7 LANDED LEGACIES: LONGEVITY AND LAND TENURE IN THE GARDEN CITY OF CARACOL, BELIZE

Adrian S.Z. Chase

Maya peoples built and occupied the city of Caracol, Belize for over 1,500 years. In that time, they integrated the needs of their natural and built environments to create sustainable communities across their neighborhoods, districts, and the city as a whole. Initial residents modified the Vaca Plateau through large-scale transformations of the landscape to create a resilient system of agricultural terraces. The impact of these terraces cannot be understated, especially since they still increase the health and height of the modern jungle vegetation over a 1,000 years later. However, the emergence and development of this resilient field system is not fully understood. It depended on multi-generational labor investments leading to settlement history, community legacies, and land tenure. The construction, maintenance, and sustainability of the agricultural terracing in the garden city of Caracol entailed the creation of a fully anthropogenic landscape – an environment that successfully integrated natural and human elements and for over half a millennium. The longevity and long-term sustainability of this agricultural system suggest that Caracol's communities actively engaged with and managed their environment. The archaeological remnants of this terrace system, when contextualized with the associated residential groups, provide insights into ancient Maya land tenure.

Introduction

The genesis and perpetuation of land tenure systems remains a pertinent topic of academic interest that is difficult, but necessary, to understand through archaeological datasets. While some historical legal texts and testaments help provide these details for more modern Maya peoples (e.g., Christensen and Restall 2019; Christensen and Truitt 2016; Restall et al. 2005), we lack these types of documents for Maya peoples that lived before the 1500s. Instead, the archaeological records and physical remains of land tenure systems are the only remaining testaments that can provide information about how past people used and administered their lands in Prehispanic Mesoamerica.

Recently, several Mesoamerican archaeologists have made forays into investigating agricultural land ownership with a variety of hypotheses about how past residents lived, used, and interacted with their fields (Kwoka et al. 2021; LeCount et al. 2019; Thompson and Prufer 2021; see also Fedick et al. 2023). For Actuncan, LeCount and colleagues (2019:246-251) investigated land tenure through magnetometry and excavation to archaeologically look for indicators of static field boundaries as potential indicators of inheritance and property rights. However, their research appears to identify a common instead of a private or state property regime, more similar to modern practices in this region. For the Three Rivers Region of Belize, Kwoka and colleagues (2021:10) take the delineation of walls around house lots and the walls of terrace systems as indicative of private land ownership by residential groups. They focus on the remains of features that are clearly visible in their lidar data, and arrive at the conclusion that there was a more private, local form of land tenure. For Ix Kuku'il and Uxbenká in southern Belize, Thompson and Prufer (2021:2-3) observe a shift from an ideal free distribution of settlement to an ideal despotic distribution. The concepts they use to make these interpretations come from human behavioral ecology and treat people on a landscape like any other animal species. Thompson and Prufer (2021) find that a shift from more equal use of land and resources (ideal free) to more restricted use of resources greatly favored those initial settlers over time (ideal despotic), concluding that land tenure practices revolved around unequal (elite) control of the best lands with other dependent households perhaps able to work on those lands in addition to poorer fields or having access to adequate lands for farming in less ideal locations. Each of these prior research efforts envisions distinctive patterns of land tenure and arrives at divergent interpretations.

Proceeding these studies, an earlier synthetic description of land tenure by McAnany (1995) focused on ritual and social practices revolving around the use and treatment of ancestral remains and how these remains permitted households to effectively enclose public lands and create tangibly inheritable places tied to familial legacies. This research, on how public spaces can be made private and inheritable, echoes other studies on historic enclosure movements worldwide, which saw the privatization of remaining public lands through fencing in the "commons" (see

Research Reports in Belizean Archaeology, Vol. 19, 2025, pp. 71-81.

for example Dyer 2006). The use of burials, remains, and rituals permitted a multi-generational means of embedding land claims within ancestral lineages (McAnany 1995). Separately, Montmollin (1989) tested settlement and agricultural distributions against political models to ultimately reject the possibly of a feudal land management system within the Rosario Valley in favor of a mixed system of more local and community management. Most of this prior research contains common threads that weave together a concern and interest in what private land ownership looks like, often focusing on residential compounds and walls but still showcasing a mixture of more communal, public land tenure systems.

Defining Land Tenure

I define *land tenure* as the system whereby the abilities and responsibilities to use land – including notions of land ownership – are determined. This can be reflected through the organization of relationships among residents involving rights, responsibilities, and privileges to use particular parts of the landscape for certain activities. However, in order for individuals and communities to abide by an overarching system of management, that system of land tenure also needs to maintain its legitimacy for them over time. As such, investigations of land tenure require an understanding of (1) how the management system itself is organized, (2) what privileges and responsibilities individuals and groups who manage land actually possess, and, (3) how the whole system maintains legitimacy and perpetuates itself through its institutions. Archaeologically, this remains a very difficult problem and requires an understanding of the overlapping nature of use, reuse, and palimpsest modifications on landscapes across generations (Wilkinson 2003) in conjunction with survey and excavation datasets.

Ideally, different management systems indicative of land tenure practices by categories such as smallholders, corporate groups, state entities, and peasants should all be distinctive from each other – although a substantial amount of data may be required to properly interpret the overarching system. Based on these four "idealized" types, the differences in management form can be codified along two axes. Along the first axis is the degree of *direct relationships* and connections between

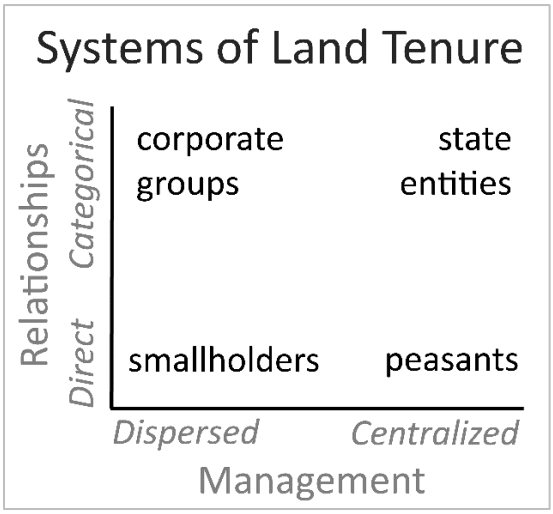

Figure 1. Framework of land tenure showing overlaps between smallholder, corporate group, state entity, and peasant forms of land tenure focusing on the kinds of interpersonal relationships (relational or categorical) along with the method of management (dispersed to concentrated).

individuals (e.g., smallholders and peasants) as opposed to more *categorical relationships* of shared affiliations to a larger group based on shared membership (e.g., corporate groups and state entities). The second axis is the degree of *dispersed management* among multiple individuals (e.g., corporate groups and smallholders) versus *centralized management* concentrated in a more hierarchical fashion (e.g., state entities and peasants) over the land tenure system as a whole. This framework (Figure 1) provides one way of understanding some of the fundamental differences we should expect between four different systems of land tenure.

Smallholders often manage farmland worldwide in extended family groups focusing on smaller plots of land around 2 hectares in size. A substantial archaeological and anthropological literature already exists for these households (e.g., Erickson 2006; Netting 1993; Pyburn 1998). Family members living on or near their fields have a direct relationship to each other (along with categorical similarities). At the same time from the top-down perspective this system is decentralized with each family operating its own fields. At Caracol, this system would apply to the extended family groups living in *plazuela* residential groups. This form of more individual ownership and community coordination (for larger endeavors) appears to be common to several locally managed systems

with smaller population sizes – where everyone can know each other directly and hold each other accountable (see Ostrom 2007; Ostrom 2009).

Corporate groups and collective community management exist among modern Maya peoples in Mexico, Belize, and Guatemala, and collective action and corporate groups have been a focus of archaeological research for decades (see in particular Blanton and Fargher 2008; Blanton et al. 1996). These systems have a variety of forms, but essentially the community comes to a consensus – through a variety of mechanisms – on how to allocate fields among community members with assignments that can vary from year-to-year, remain static over time, or mix both forms of tenure. These groups by their very nature exhibit a strong categorical identity based on living together in their villages or towns. The common living situation and shared group membership help everyone build a common categorical identity, especially when population sizes are under 500 people, as they are in the neighborhoods of Caracol (see Chase 2023a:3-4). Thus, we could see corporate groups if agricultural terrace construction is indicative of neighborhood-level management at Caracol through shared construction techniques and delineations and boundaries between different neighborhood groups along with architectural remains of community houses.

Identification of corporate group land tenure can also rely on multiple, overlapping systems of institutional management, and mixtures of residential and community management can coexist as they likely did at sites like Chan (see Wyatt 2012, 2014). Some aspects of the landscape at Caracol could support more community-centered management such as the zig-zag-ing nature of terrace water flows along a terrace drainage system and very infrequent terraces with long retaining walls (both described in the next section); however, neither of these features, the distribution of residential groups (Chase et al. 2024), nor the distribution of reservoirs at Caracol (Chase 2016a) suggests a clear corporate group management strategy at the neighborhood-level. Based on current information, more collective management within Caracol's agricultural system likely occurred among multiple households in a more *ad hoc*, localized fashion below the level of the neighborhood as a whole or through the adjudication of disputes by officials in neighborhood, district, or city offices.

State entities tend to exhibit a strong bureaucratic aspect to their management systems with high levels of standardization, which make things easier to quantify and organize. Within the Americas, the Inca and their agricultural terraces provide a perfect example of this more centralized, top-down management to land tenure (see D'Altroy 2015; contra Erickson 2006). The centralized nature of these entities tends to elicit standardization in designs and practices, with a strong focus on the specific group's categorical identity at play – and also carrying the full weight of state action and force. Within Caracol, the city's administrative districts could represent this type of bureaucratic, top-down management, but at an intermediate social level (Chase 2024). Caracol's districts provisioned urban services to their residents and each managed between 2000 and 10,000 people (Chase 2016b, 2021). Boundaries between districts or standardized construction among them could be indicative of district management practices. Alternatively, standardized terraces throughout the city could be indicative of centralized organization of agriculture at the city-wide level. But, again, this is not the case for Caracol (see Chase 2023c).

Peasants exist in a system whereby a local elite has authority to personally allocate land for work, and underpins any two-class system of elites and commoners. The local elite would own the land, but the peasants would farm it and owe agricultural goods to that elite individual who often acts on behalf of a more powerful elite patron. This is a system of direct relational connections among elites and of unequal relationships between elites and the peasants who work on the lands owned by their local elites. The term peasant, while widely used in earlier anthropological literature, denotes only one of many types of unequal relationship between landowner and land-worker along a spectrum of multiple systems that include wage labor, sharecropping, peasants, serfdom, and slavery (from more to less free). Specific differences in rights and responsibilities between land-owner and land-worker may vary widely between historical periods and contexts. Fundamentally, these separate categories indicate differential rights and abilities of those working the land to leave – as well as other aspects of the roles and

relationships between these individuals and their landowners. While these roles, relationships, and responsibilities may shift, what is constant is that some individuals administer and own the land while "permitting" (depending on the system) others to work that land.

This system has been investigated thoroughly in Europe (Chayanov 1986; Wolf 1966), and may match some related models of elites and commoners in terms of labor obligations (Walden et al. 2023). At Caracol, this system would be exhibited by patterns centered not around neighborhoods and districts, but around larger residences (*sensu* Montmollin 1989) – possibly like those seen around Tikal, Guatemala (Estada-Belli et al. 2023). However, this type of system is highly unlikely at Caracol given the high degree of equality present in residential size at Caracol (A. S. Z. Chase et al. 2023:10-16) that mirrors inequality measurements of much smaller settlements (see details in Thompson et al. 2023) even though Caracol's residents had a higher overall wealth present in portable materials than their compatriots at other centers (Chase and Chase 2015; Chase et al. 2015; D. Z. Chase and A. F. Chase 2014a). The distribution of the largest residences within the city also does not lend itself to a clear pattern of local elites embedded across the landscape (Chase 2021:197-267). Additionally, the widespread nature of wealth sharing, shared ritual practices, and other indicators of "people in-the-middle" prevent any bimodal system like that of "elites" and "commoners" from being widely applicable to the residents of Caracol.

Agricultural Terraces at Caracol, Belize

At Caracol, the palimpsest of cultural remains that exists within the lidar data (Chase et al. 2014; Chase et al. 2011) show activity primarily between 650 and 800 CE as the city reached its highest population and largest spatial extent before its residents left (see also Chase 2023b; A. S. Z. Chase et al. 2024). By the Terminal Classic, agricultural terraces (Figures 2 and 3) covered minimally 160 square kilometers of Caracol's urban area in Belize (Chase and Weishampel 2016:360). Terraces occupy hilltops, hillsides, and valleys while exhibiting a wide variety of construction techniques (Healy et al. 1983:402-405). However, the terrace system visible today most likely saw initial expansion around 550 CE with

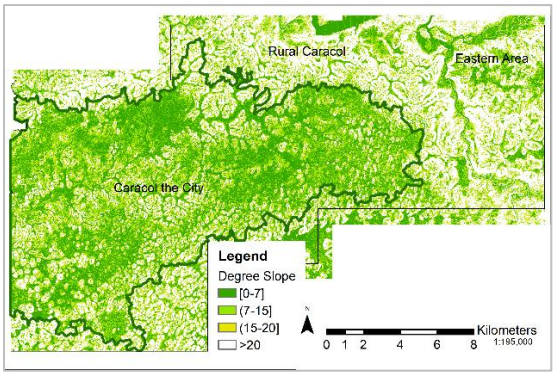

Figure 2: Slope map of Caracol, Belize and areas to the outside of Caracol (Rural) and East of Caracol – for contrast – with slope values binned into four categories to help showcase the degree of terrace construction. The agricultural terraces within the more urbanized areas of Caracol actively reduce the slope as can be seen in contrast to the higher slopes and fewer, valley terraces located within the Rural and Eastern areas.

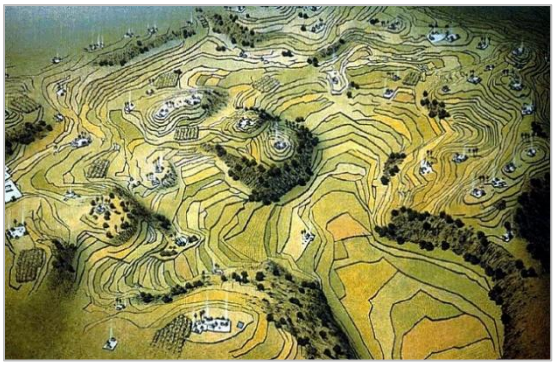

Figure 3. Artistic reconstruction (by T. Rutledge and D. Morgan) of agricultural terraces in the Monterey district of Caracol, Belize (reproduced from Chase and Chase 1998: Figure 1)

construction efforts beginning in the valleys and then moving up the slopes over time to encompass most of the landscape. The end of new terrace construction is likely at or just after 800 CE (dates from Chase and Chase 1998:72). Any earlier terraces and other land modifications preceding this system were likely erased by construction during the Late Classic, but excavations by Healy et al. (1983) indicate that some early agricultural terraces were put in place between 150 and 550 CE (Figure 4).

Human occupation of Caracol's landscape for 1,500 years required sustainable long-term practices. While initial agricultural practices probably took advantage of the ample space to practice cultivation in forest gardens (Ford 2015; Ford and Nigh 2009), urban processes within the garden city (Chase and Chase 1987:53; 1998) would have eventually required a phase change in agricultural practices through a shift to and reliance on

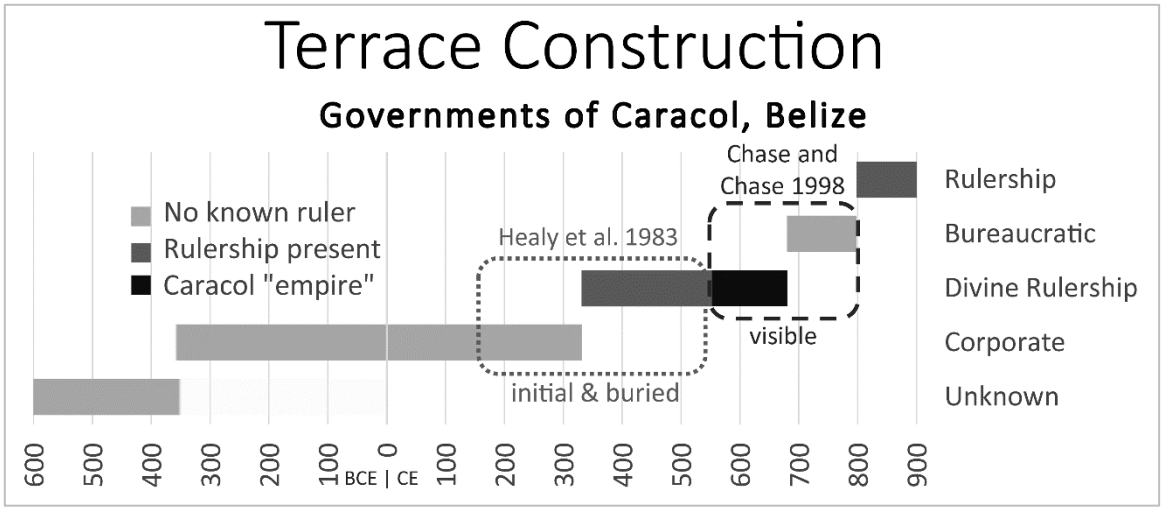

Figure 4. Two separate phases of agricultural terrace construction at Caracol, Belize shown over the historical periods, and diachronic shifts in governance (from Chase 2023c). Early construction efforts appear to occur between 150 and 550 CE with most currently visible construction dating between 550 and 800 CE.

agricultural terraces (D. Z. Chase and A. F. Chase 2014b). In other words, the residents of Caracol eventually accepted a trade-off – perhaps unintentionally – and gave up a system of greater production per hour of labor spent over a wider area to one of increased total production but with more total labor required over smaller spaces (*sensu* Boserup 2008). Terraces and intensification remain tied together; agricultural terraces were not built for asynchronous cultivation and forest garden practices. If societies shifted back to other modes of agricultural production through *disintensification*, then they used the palimpsest landscape left from prior periods (Brookfield 1972, 1984, 2001).

Caracol's agricultural terraces exist in systems of controlled drainage with water essentially flowing back-and-forth across the terraces in a zig-zag-ing fashion downhill. Because of this, terraces reduce soil erosion and increase infiltration of water into the root zone (Chase and Weishampel 2016); they also increase the height and health of the modern forest canopy (Hightower et al. 2014). The residents of Caracol constructed their agricultural terraces to minimize the damage that too much water from a heavy rain would do to their crops and to reduce soil erosion, while also ensuring that rainfall provided sufficient sustenance for their crops. Infiltrated water was safely stored in the root zone, slowly moving and flowing down the terrace system just above the bedrock layer from field to field, long after the rain has passed. This slow subsurface flow helped to provide sufficient moisture for roots without drowning them. Taken together, these terraces indicate the high degree of traditional ecological knowledge needed by local farmers to successfully grow crops in this fully anthropogenic landscape.

The resiliency of these terraces manifests in their current ability to encourage jungle growth despite 1000 years without maintenance (Hightower et al. 2014). Ample evidence for the complete manipulation of soils down to bedrock can be seen in the removal of all but the smallest stones under 1 mm from their fields and the lack of a decomposed bedrock soil horizon (Healy et al. 1983:406). The soils themselves also exhibit higher levels of nutrients like phosphorus (Coultas et al. 1994); phosphorus normally limits plant growth in jungle soils because it is locked up in the forest canopy. The high phosphorus levels of these terrace soils also provide an indirect indication of night soiling practices at Caracol (Coultas et al. 1994) and showed that its residents had closed the P-cycle – naturally moving phosphorus through the ecological system as a whole – more successfully than we have today (Childers et al. 2011). In short, Caracol's landscape was a fully anthropogenic mix of human and ecological systems (Chase and Chase 2016a, 2016b), and a landscape that could sustainably support 100,000 people at least in terms of primary agricultural foodstuffs (Dahlin and Chase 2014; Murtha 2009) with other necessary materials arriving via economic networks and market exchange (Chase and

Chase 2015; Chase et al. 2015; D. Z. Chase and A. F. Chase 2014a).

Discussion

Fundamentally, most of the labor spent in constructing new terraces lies in the energetic costs of removing soils down to bedrock and building the retaining wall – ideally with materials excavated from the terrace itself to minimize costs (see Abrams 1994; Erasmus 1965). That being said, the construction of the whole system of terraces likely occurred over several generations in the 250 years from at least 550 to 800 CE (in addition to the 400 years from 150 to 550 CE for initial terrace construction efforts), which would greatly amortize the energetic cost of this terrace system over time (and generations). Additionally, even a smallholder system of management could build terraces by working with their neighbors (or other local district residents) during the construction of a new terrace. This smallholder safety net of labor sharing – if it existed – would then act as part of a system of reciprocity between *plazuelas* that could have helped provide labor or food when needed – a system emblematic of small-scale endeavors and mutually-supportive community interactions that facilitate other collective action when needed (Blanton and Fargher 2008; Feinman and Carballo 2018; Ostrom 2015). Importantly, this form of reciprocity is indicative of how collective action functions without requiring the creation of a corporate group; however, more formalized institutions for community management would lead to even greater reciprocity.

Management of the System

The agricultural terraces at Caracol do not exhibit the same standardized and centralized construction that the Inca used in their terrace systems (e.g., D'Altroy 2015; Valdivia 2002). In combination with the more varied construction techniques that occur at Caracol – even within districts and neighborhoods – this suggests more localized management than the city-wide or polity levels. However, when the rain falls, these terraces drain from one into another creating a system of terraces that can be negatively impacted by the mismanagement of an elevated field, strongly suggesting that some form of larger governance existed, if only to handle the infrequent disputes that could not be resolved locally (see Chase 2024). Additionally, some rare individual terrace walls can continue for several hundred meters; one 250-meter-long terrace wall was documented during ground survey (Healy et al. 1983:404) and another is estimated at nearly 1 kilometer in length (Chase and Chase 1998:70). These longer agricultural terraces on their own do not establish what the full management system looked like, but do strongly suggest that organization above that of the individual *plazuela* group would have been required for at least some terraces.

Abilities and Responsibilities

The widespread construction of agricultural terraces suggests that multiple families and groups had access to terraced fields, and current research strongly suggests each residence at Caracol had access to approximately 2.2 ha of land (Chase and Chase 2015:17). Given the size of the residential *plazuelas* at Caracol and ethnographic examples, it is likely that each supported an average of 10 people, representing an extended family group (see A. F. Chase et al. 2024). Such farmstead groupings of extended families in residential units were common before the Industrial Revolution, and they often had access to around two hectares of farmland – something that can still be seen today for most modern family-run farms in less-industrialized regions (Lowder et al. 2016). This ratio provides additional evidence for smallholder management by *plazuela* groups, but requires future analyses to fully test systematically to compare and contrast residential size, household materials, and proximate fields. The most likely responsibilities of tending a terraced field included, at a minimum, physical maintenance of that terrace within the larger system to prevent down-system issues as well as active prevention of weeds or pests from propagating to neighboring fields. Thus, responsibilities for preventing issues among differently owned agricultural terraces were surely in place.

Legitimacy and Perpetuation

The shift to agricultural terraces almost certainly enabled and permitted the Late Classic population of Caracol to remain sustainable and agriculturally self-sufficient for several hundred years, but cities require more than just agriculture alone to thrive. The increase in agricultural terracing ties in directly

to an increase in residential specialization among households (A. F. Chase and D. Z. Chase 2014; D. Z. Chase, A. F. Chase, et al. 2023) and urban service provisioning features and communal architecture within the city (Chase 2023c, 2024). The Late Classic period at Caracol saw the development of more equality among residents (Chase and Chase 2009) followed in the Terminal Classic by greater inequality (D. Z. Chase, A. F. Chase, et al. 2023) before the depopulation of this city. Thus, the agricultural sustainability and resilience exhibited by the agricultural terrace system did not mitigate the other social, economic, and political tensions that led to rising inequality and social instability at Caracol. Long-term settlement sustainability requires more than just environmental factors to be aligned.

Conclusion

Archaeological research produces the only long-term datasets that we can use to understand sustainability and resilience (Chase and Scarborough 2014; D. Z. Chase, J. Lobo, et al. 2023). It may not always provide data in desired ways, but eventually the weight of evidence permits interpretation. Within the grand questions of human history, the origins and perpetuation of land tenure systems remain a difficult but important topic to disentangle and understand. However, by examining types of land tenure systems based on smallholders, corporate groups, state entities, and peasants, it is possible to gain perspectives on how peoples managed fields and farmlands.

At Caracol our current understanding from spatial, archaeological, and ecological datasets points towards agricultural terraces largely being managed by smallholders of extended family groups at the *plazuela* level. These smallholders still engaged in collective endeavors to aid in the incremental process of terrace construction over several hundred years. Larger social entities at the neighborhood and district levels would have helped to manage any disputes that arose and provided the labor-base for more substantial construction projects. Future research will be able to better investigate the distribution of field and residential sizes against the material remains present in the households to more fully understand the intricacies and effects of land tenure practices at Caracol.

The continuous spatial covering of agricultural terraces across the Caracol landscape exhibits a wide variety of sizes and construction methods that seemingly rules out clear corporate neighborhood and district entity management of lands – especially with continuous, unbroken settlement across their boundaries and the lack of community houses to aid in administration. The few singularly long terraces may have been administered differently from the more localized systems around smallholders. While no particular management system can be signaled out without additional data, these longer terraces could have resulted from flukes of local construction efforts or, alternatively, could possibly represent ownership by larger – or wealthier – households or even the ruler with some share of the crop on these fields going to support military efforts (sensu Hassig 2016) or granary storage (following Lamoureux-St-Hilaire 2022). Their existence, however, does not mitigate the widespread nature of what appear to be more locally managed smallholder fields and the absence of neighborhood-level community buildings.

Lastly, archaeological data showcases relative equality among the householders at Caracol with several markers indicating a large and strong middle-status group that rules out any strict binary or commoner-elite dichotomy (Chase and Chase 1992, 2017). While other settlements and sites may have had land tenure arrangements reflecting this bimodal distribution of unequal statuses, its lack at Caracol may be one of the factors that led to tremendous population growth and in-migration at Caracol in the Late Classic Period (A. S. Z. Chase et al. 2024). Besides Caracol (Chase 2017:35-37; A. S. Z. Chase et al. 2023:9-10; Chase and Chase 1996) archaeological data from other Maya cities also indicates the existence of multiple status levels (Chase 1986:362; Hutson 2020:409-412; Masson and Pereza Lope 2005). Thus, the social model that existed at Caracol was not unique and represents part of a more widespread model of social organization, suggesting that the smallholder model of agriculture could have been similarly widespread. Despite being amortized over time, the degree of labor invested in the agricultural terraces at Caracol towers over that invested in the city's monumental architecture, public plazas, and causeway system – and that

investment of time and energy strongly indicates a system of smallholders who anticipated multi-generational benefits from their efforts.

Acknowledgements This research could not have occurred without the decades of effort at Caracol, Belize by past researchers for multiple archaeological projects – in particular the Caracol Archaeological Project. Additionally, the author would like to thank Christopher Morehart for encouraging in-depth reading of agricultural theory during graduate education at Arizona State University.

References Cited

Abrams, Elliot M.
1994 *How the Maya Built Their World: Energetics and Ancient Architecture*. University of Texas Press, Austin.

Blanton, Richard E., and Lane F. Fargher.
2008 *Collective Action in the Formation of Pre-Modern States*. Springer, New York, NY.

Blanton, Richard E., Gary M. Feinman, Stephen A. Kowalewski, and Peter N. Peregrine.
1996 A Dual-Processual Theory for the Evolution of Mesoamerican Civilization. *Current Anthropology* 37(1):1-14.

Boserup, Ester.
2008 *The Conditions of Agricultural Growth*. 3rd ed. AldineTransaction, New Brunswick, NJ.

Brookfield, Harold C.
1972 Intensification and Disintensificaiton in Pacific Agriculture. *Pacific Viewpoint* 13(1):30-48.

Brookfield, Harold C.
1984 Intensification revisited. *Pacific Viewpoint* 25(1):15-44.

Brookfield, Harold C.
2001 Intensification, and Alternative Approaches to Agricultural Change. Article. *Asia Pacific Viewpoint* 42(2):181.

Chase, Adrian S.Z.
2016a Beyond elite control: residential reservoirs at Caracol, Belize. *WIREs Water* 3(6):885-897.

Chase, Adrian S.Z.
2016b Districting and Urban Services at Caracol, Belize: Intrasite Boundaries in an Evolving Maya Cityscape. *Research Reports in Belizean Archaeology* 13:15-28.

Chase, Adrian S.Z.
2017 Residential Inequality Among the Ancient Maya: Operationalizing Household Architectural Volume at Caracol, Belize. *Research Reports in Belizean Archaeology* 14:31-39.

Chase, Adrian S.Z.
2021 Urban Life at Caracol, Belize: Neighborhoods, Inequality, Infrastructure, and Governance. PhD, School of Human Evolution and Social Change, Arizona State University, Tempe.

Chase, Adrian S.Z.
2023a Reconstructing and testing neighborhoods at the Maya city of Caracol, Belize. *Journal of Anthropological Archaeology* 70:101514.

Chase, Adrian S.Z.
2023b Transformation, Growth, and Governance at Caracol, Belize. *Research Reports in Belizean Archaeology* 18:19-30.

Chase, Adrian S.Z.
2023c Urban Planning at Caracol, Belize: Governance, Residential Autonomy, and Heterarchical Management through Time. In *Building an Archaeology of Lowland Maya Urbanism: Planning and Flexibility in the American Tropics*, edited by Damien B. Marken, and M. Charlotte Arnauld, pp. 349-376. University Press of Colorado, Boulder.

Chase, Adrian S.Z.
2024 Urban Levels at Caracol, Belize: Understanding Social Relationships at the Plazuela, the Neighborhood, the District, and the City Levels. In *Neighborhood and District Integration in the Andes and Mesoamerica*, edited by Gabriela Cervantes Quequezana, and John P. Walden, pp. 137-156. Center for Comparative Archaeology University of Pittsburgh, Pittsburgh.

Chase, Adrian S.Z., Elyse D.Z. Chase, Diane Z. Chase, and Arlen F. Chase.
2024 Population History for Caracol, Belize: Numbers, Complexity, and Urbanism. In *Ancient Mesoamerican Population History: Urbanism, Social Complexity, and Change*, edited by Adrian S.Z. Chase, Arlen F. Chase, and Diane Z. Chase, pp. 67-88. Amerind Studies in Anthropology. University of Arizona Press, Tucson.

Chase, Adrian S.Z., Amy E. Thompson, John P. Walden, and Gary M. Feinman.
2023 Understanding and calculating household size, wealth, and inequality in the Maya Lowlands. *Ancient Mesoamerica* 34(3):e1.

Chase, Adrian S.Z., and John F. Weishampel.
2016 Using LiDAR and GIS to Investigate Water and Soil Management in the Agricultural Terracing at Caracol, Belize. *Advances in Archaeological Practice* 4(3):357-370.

Chase, Arlen F. , and Vernon L. Scarborough (editors).
2014 *The Resilience and Vulnerability of Ancient Landscapes: Transforming Maya Archaeology through IHOPE*. Archeological Papers of the American Anthropological Association. Vol AP3A Paper 24. American Anthopolgoical Association, Arlington, VA.

Chase, Arlen F., and Diane Z. Chase.
1987 *Investigations at the Classic Maya City of Caracol, Belize, 1985-1987*. Pre-Columbian Art Research Institute, San Francisco, USA.

Chase, Arlen F., and Diane Z. Chase.
1996 The Organization and Composition of Classic Lowland Maya Society: The View from Caracol, Belize. In *Eighth Palenque Round Table, 1993*, edited by Merle Greene Robertson, Martha J. Macri, and Jan McHargue, pp. 213-222. Pre-Columbian Art Research Institute, San Francisco.

Chase, Arlen F., and Diane Z. Chase.
1998 Scale and Intensity in Classic Period Maya Agriculture: Terracing and Settlement at the "Garden City" of Caracol, Belize. *Culture & Agriculture* 20(2-3):60-77.

Chase, Arlen F., and Diane Z. Chase.
2009 Symbolic Egalitarianism and Homogenized Distributions in the Archaeological Record at Caracol, Belize: Method, Theory, and Complexity. *Research Reports in Belizean Archaeology* 6(1):15-24.

Chase, Arlen F., and Diane Z. Chase.
2014 Ancient Maya Houses, Households, and Residential Groups at Caracol, Belize. *Research Reports in Belizean Archaeology* 11:3-17.

Chase, Arlen F., and Diane Z. Chase.
2015 The Domestic Economy of Caracol, Belize: Articulating with the Institutional Economy in an Ancient Maya Urban Setting. *Research Reports in Belizean Archaeology* 12:15-23.

Chase, Arlen F., and Diane Z. Chase.
2016a The Ancient Maya City: Anthropogenic Landscapes, Settlement Archaeology, and Caracol, Belize. *Research Reports in Belizean Archaeology* 13:3-14.

Chase, Arlen F., and Diane Z. Chase.
2016b Urbanism and Anthropogenic Landscapes. *Annual Review of Anthropology* 45:361-376.

Chase, Arlen F., Diane Z. Chase, Jaime J. Awe, John F. Weishampel, Gyles Iannone, Holley Moyes, Jason Yaeger, et al.
2014 Ancient Maya Regional Settlement and Inter-Site Analysis: The 2013 West-Central Belize LiDAR Survey. *Remote Sensing* 6(9):8671-8695.

Chase, Arlen F., Diane Z. Chase, and Adrian S.Z. Chase.
2024 Archaeological Population Studies in Mesoamerica. In *Ancient Mesoamerican Population History: Urbanism, Social Complexity, and Change*, edited by Adrian S.Z. Chase, Arlen F. Chase, and Diane Z. Chase, pp. 5-41. Amerind Studies in Anthropology. University of Arizona Press, Tucson.

Chase, Arlen F., Diane Z. Chase, Richard Terry, Jacob M. Horlacher, and Adrian S.Z. Chase.
2015 Markets Among the Ancient Maya: The Case of Caracol, Belize. In *The Ancient Maya Marketplace: The Archaeology of Transient Space*, edited by E. King, pp. 226-250. University of Arizona Press, Tucson, AZ.

Chase, Arlen F., Diane Z. Chase, John F. Weishampel, Jason B. Drake, Ramesh L. Shrestha, K. Clint Slatton, Jaime J. Awe, and William E. Carter.
2011 Airborne LiDAR, archaeology, and the ancient Maya landscape at Caracol, Belize. *Journal of Archaeological Science* 38(2):387-398.

Chase, Diane Z.
1986 Social and Political Organization in the Land of Cacao and Honey: Correlating the Archaeology and Ethnohistory of the Lowland Postclassic Maya. In *Late Lowland Maya Civilization: Classic to Postclassic Postclassic*, edited by Jeremy A. Sabloff, and E.W. Andrews V, pp. 347-377. University of New Mexico Press, Albuquerque.

Chase, Diane Z., and Arlen F. Chase (editors).
1992 *Mesoamerican Elites: An Archaeological Assessment*. University of Oklahoma Press, Norman, OK.

Chase, Diane Z., and Arlen F. Chase.
2014a Ancient Maya Markets And The Economic Integration Of Caracol, Belize. *Ancient Mesoamerica* 25:239-250.

Chase, Diane Z., and Arlen F. Chase.
2014b Path Dependency in the Rise and Denouement of a Classic Maya City: The Case of Caracol, Belize. In *The Resilience and Vulnerability of Ancient Landscapes: Transforming Maya Archaeology through IHOPE*, Vol AP3A Paper 24, edited by Arlen F. Chase, and Vernon L. Scarborough, pp. 142-154. Archeological Papers of the American Anthropological Association, Vol. 24. American Anthropological Association, Arlington, VA.

Chase, Diane Z., and Arlen F. Chase.
2017 Caracol, Belize, and Changing Perceptions of Ancient Maya Society. *Journal of Archaeological Research* 25(3):185-249.

Chase, Diane Z., Arlen F. Chase, and Adrian S.Z. Chase.
2023 Economic and Socio-Political Change during the Classic and Terminal Classic Periods at Caracol, Belize. In *Ancient Maya Embedded Economies*, edited by Bernadette Cap, and

Rachel A. Horowitz. University Press of Colorado, Boulder.

Chase, Diane Z., José Lobo, Gary M. Feinman, David M. Carballo, Arlen F. Chase, Adrian S.Z. Chase, Scott R. Hutson, et al.
2023 Mesoamerican urbanism revisited: Environmental change, adaptation, resilience, persistence, and collapse. *Proceedings of the National Academy of Sciences* 120(31):e2211558120.

Chayanov, A.V.
1986 *The Theory of Peasant Economy*. Daniel Thorner, Basile Kerblay, and R. E. F. Smith. University of Wisconsin Press, Madison, WI.

Childers, Daniel L., Jessica Corman, Mark Edwards, and James J. Elser.
2011 Sustainability Challenges of Phosphorus and Food: Solutions from Closing the Human Phosphorus Cycle. *BioScience* 61(2):117-124.

Christensen, Mark, and Matthew Restall.
2019 *Return to ixul: Maya Society in an Eighteenth-Century Yucatec Town*. University Press of Colorado, Louisville.

Christensen, Mark, and Jonathan Truitt (editors).
2016 *Native Wills from the Colonial Americas: Dead Giveaways in a New World*. University of Utah Press, Salt Lake City.

Coultas, C. Lynn, Mary E. Collins, and Arlen F. Chase.
1994 Some Soils Common to Caracol, Belize and Their Significance to Ancient Agriculture and Land Use. In *Studies in the Archaeology of Caracol, Belize*, edited by D. Chase, and A. Chase, pp. 21-33. Pre-Columbian Art Research Institute Monograph, San Francisco.

D'Altroy, Terence N.
2015 *The Incas*. 2nd edition ed. The Peoples of America. Blackwell Publishing, Malden, MA.

Dahlin, Bruce H., and Arlen F. Chase.
2014 A Tale of Three Cities: Effects of the A.D. 536 Event in the Lowland Maya Heartland. In *The Great Maya Droughts in Cultural Context: Case Studies in Resilience and Vulnerability*, edited by Gyles Iannone, pp. 127-155. University Press of Colorado, Boulder.

Dyer, Christopher.
2006 Conflict in the landscape: the enclosure movement in England, 1220–1349. *Landscape History* 28(1):21-33.

Erasmus, Charles J.
1965 Monument Building: Some Field Experiments. *Southwestern Journal of Anthropology* 21(4):277-301.

Erickson, Clark L.
2006 Intensification, Political Economy, and the Farming Community; In Defense Of A Bottom-Up Perspective Of The Past. In *Agricultural Strategies*, edited by Joyce Marcus, and Charles Stanish, pp. 233-265. Cotsen Institute, Los Angeles, CA.

Estrada-Belli, Francisco, Laura Gilabert-Sansalvador, Marcello A. Canuto, Ivan Šprajc, and Juan Carlos Fernandez-Diaz.
2023 Architecture, wealth and status in Classic Maya urbanism revealed by airborne lidar mapping. *Journal of Archaeological Science* 157:105835.

Fedick, Scott, L, Shanti Morell-Hart, and Lydie Dussol.
2023 Agriculture in the Ancient Maya Lowlands (Part 2): Landesque Capital and Long-term Resource Management Strategies. *Journal of Archaeological Research* 32:103-154.

Feinman, Gary M., and David M. Carballo.
2018 Collaborative and competitive strategies in the variability and resiliency of large-scale societies in Mesoamerica. *Economic Anthropology* 5(1):7-19.

Ford, Anabel.
2015 *The Maya Forest Garden*. New Frontiers in Historical Ecology. Routledge, New York.

Ford, Anabel, and Ronald Nigh.
2009 Origins of the Maya Forest Garden: Maya Resource Management. *Journal of Ethnobiology* 29(2):213-236.

Hassig, Ross.
2016 Aztec Logistics and the Unanticipated Consequences of Empire. In *The Archaeology of Food and Warfare: Food Insecurity in Prehistory*, edited by Amber M. VanDerwarker, and Gregory D. Wilson, pp. 149-160. Springer, Cham.

Healy, Paul F., John D. H. Lambert, J. T. Arnason, and Richard J. Hebda.
1983 Caracol, Belize: Evidence of Ancient Maya Agricultural Terraces. *Journal of Field Archaeology* 10(4):397-410.

Hightower, Jessica, A. Butterfield, and John Weishampel
2014 Quantifying Ancient Maya Land Use Legacy Effects on Contemporary Rainforest Canopy Structure. *Remote Sensing* 6(11):10716.

Hutson, Scott R.
2020 Inequality and social groups. In *The Maya World*, edited by Scott R. Hutson, and Traci Ardren, pp. 407-423. The Routledge Worlds. Routledge, New York.

Kwoka, Joshua J., Thomas H. Guderjan, Sara Eshleman, Thomas Ruhl, Justin Telepak, Timothy Beach, Sheryl Luzzadder-Beach, Will McClatchey, and Grace Bascopé.
2021 A multimethod approach to the study of Classic Maya houselots and land tenure: Preliminary results from the Three Rivers Region, Belize. *Journal of Archaeological Science: Reports* 38:103049.

Lamoureux-St-Hilaire, Maxime
2022 The tapir in the room: Ancient Maya storage architecture. *Journal of Anthropological Archaeology* 68:101467.

LeCount, Lisa J., Chester P. Walker, John H. Blitz, and Ted C. Nelson
2019 Land Tenure Systems at the Ancient Maya Site of Actuncan, Belize. *Latin American Antiquity* 30(2):245-265.

Lowder, Sarah K., Jakob Skoet, and Terri Raney
2016 The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide. *World Development* 87:16-29.

Masson, Marilyn A., and Carlos Pereza Lope
2005 Commoners in Postclassic Maya Society: Social versus Economic Constructs. In *Ancient Maya Commoners*, edited by Jon C. Lohse, and Fred Jr. Valdez, pp. 197-223. University of Texas Press, Austin.

McAnany, Patricia A.
1995 *Living with the Ancestors: Kinship and Kingship in Ancient Maya Society*. University of Texas Press, Austin.

de Montmollin, Olivier
1989 Land Tenure and Politics in the Late/Terminal Classic Rosario Valley, Chiapas, Mexico. *Journal of Anthropological Research* 45(3):293-314.

Murtha, Timothy
2009 *Land and Labor, Maya Terraced Agriculture: An Investigation of the Settlement Economy and Intensive Agricultural Landscape of Caracol, Belize*. Verlag Dr. Müller, Saarbruckan, Germany.

Netting, Robert McC.
1993 *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture*. Stanford University Press, Stanford.

Ostrom, Elinor
2007 Collective Action Theory. In *Oxford Handbook of Comparative Politics*, edited by Carles Boix, and Susan C. Stokes, pp. 186-208. Oxford University Press, New York, NY.

Ostrom, Elinor
2009 A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science* 325(5939):419-422.

Ostrom, Elinor
2015 *Governing the Commons: The Evolution of Institutions for Collective Action*. 2nd ed. Cambridge University Press, Cambridge.

Pyburn, K. Anne
1998 Smallholders in the Maya Lowlands: Homage to a Garden Variety Ethnographer. *Human Ecology* 26:267-286.

Restall, Matthew, Lisa Sousa, and Kevin Terraciano (editors)
2005 *Mesoamerican Voices: Native-Language Writings from Colonial Mexico, Oaxaca, Yucatan, and Guatemala*. Cambridge University Press, New York.

Thompson, Amy E., Adrian S.Z. Chase, and Gary M. Feinman
2023 Measuring inequality: The effect of units of analysis on the Gini coefficient. *Ancient Mesoamerica* 34(3):e2.

Thompson, Amy E., and Keith M. Prufer
2021 Household Inequality, Community Formation, and Land Tenure in Classic Period Lowland Maya Society. *Journal of Archaeological Method and Theory* (28):1276–1313.

Valdivia, Roberto Oscar
2002 The Economics of Terraces in the Peruvian Andes: an Application of Sensitivity Analysis in an integrated Assessment Model. Masters Masters Thesis, Montana State University, Montana State University, Bozeman, USA.

Walden, John P., Julie A. Hoggarth, Claire E. Ebert, Scott L. Fedick, Michael Biggie, Brett Meyer, Kyle Shaw-Müller, et al.
2023 Classic Maya Settlement Systems Reveal Differential Land Use Patterns in the Upper Belize River Valley. *Land* 12(2). DOI: 10.3390/land12020483.

Wilkinson, Tony J.
2003 *Archaeological Landscapes of the Near East*. University of Arizona Press, Tucson.

Wolf, Eric Robert
1966 *Peasants*. Prentice-Hall, Englewood Cliffs, NJ, USA.

Wyatt, Andrew R.
2012 Agricultural Practices at Chan: Farming and Political Economy In an Ancient Maya Community. In *Chan: An Ancient Maya Farming Community*, edited by Cynthia Robin, pp. 71-88. University Press of Florida, Gainesville.

Wyatt, Andrew R.
2014 The scale and organization of ancient Maya water management. *WIREs Water* 1:449-467.