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Introducing the Special Feature on housing differences and inequality over the very long term

Timothy A. Kohler[a,b,c,1], Amy Bogaard[b,d], and Scott G. Ortman[b,e]

Economic inequality, especially as it relates to inclusive and sustainable social development, represents a primary global challenge of our time and a key research topic for archaeology (1, 2). It is also deeply linked to two other significant challenges. The first is climate change. This threatens to widen economic gaps within and between nations (3–5), and some evidence from prehistory associates high levels of inequality with lack of resilience to climatic perturbations (6, 7). The second is stability of governance. Clear and robust evidence from two dozen democracies over the last 25 years that links high economic inequality to political polarization, distrust of institutions, and weakening democratic norms (8). Clearly, if maintenance of democratic systems is important to us, we must care about the degree of wealth inequality in society.

This Special Feature (SF) on Economic Inequality represents a collective effort to accelerate archaeological assessment of economic inequality. The associated papers use the rich archaeological record of housing from nonindustrial societies across the world, beginning as early as late-glacial times. Archaeology reveals clear signals that inequality in wealth and income has a long prehistory, but also shows wide variation (9, 10). Archaeological data allow us to explore the fundamental drivers of economic inequality, to test ideas about inequality from recent history, and to offer novel perspectives from a uniquely broad perspective.

If the stone alignments associated with *Homo habilis* at Olduvai Gorge have been interpreted correctly (11), hominins have been constructing shelters for at least 1.7 million years. Unambiguous housing is apparent from over 20,000 years ago (12), soon becoming "a characteristic feature of human culture" (13). As settled life, often linked with farming, emerged at different times and places, houses become prominent and abundant elements of the archaeological record. Although a deep history of inequality could be based on almost any material (14) the relative durability of structural remains, their connection with basal social groups (households), the fact that their dimensions have been documented for as long as archaeology has been practiced, and the elasticity of their size with respect to wealth and prosperity, make them uniquely important for an archaeology of inequality.

Residences vary enormously according to climate and the specific environmental risks that structures must endure, the availability of raw materials and technology, characteristics of the coresident social group, cultural notions of privacy, possible provision of space for rituals, numerous cultural beliefs and practices, and even constraints imposed by regulatory bodies. They may also signal the secured or aspirational social position of the occupants, including references to their histories and occupations. Given the numerous factors potentially affecting housing around the world for the last 20,000 years, it may seem too simple a strategy to focus on just one aspect of these structures—the distribution of their floor areas across various contexts—to assess patterns of economic inequality. However, as we argue below, and as the contributions to this SF make clear, this simple metric offers a number of advantages for comparative analyses.

Focusing on housing of course implicates the coresidential group as the focus of our analysis. Although we include some structures from societies with no domesticated plants or animals, and others from urban centers where residents were not primary producers, across most of the societies examined, the farming household along with its farm was the nexus of decision-making, production, consumption and food sharing, and property ownership; it provided the stage for the dramas of birth and death (15). Processes of wealth accumulation and economic differentiation eventually involve larger social, political, and economic forces such as markets and taxation, but it will be through their effects on households that these factors become visible in our analyses.

The research design followed in this SF takes advantage of the fact that residences dating to the same chronological period, and from the same settlements or regions, will be subject to very similar climatic, environmental, technological, and cultural constraints and opportunities, holding these variables constant across analyses. Summary statistics calculated across such residences therefore provide proxies for several socioeconomic properties. The most important here is a measure of economic inequality, using Gini coefficients calculated on total house area including storage. As always, this coefficient varies from near zero, when residences are virtually identical in size, to near 1, when they differ greatly. Widely adopted by economists since its introduction in the early 20th century by Gini (16), this index is typically applied to distributions of income or wealth. Peterson and Drennan (17) have discussed interpretive issues arising with this

Author affiliations: [a]Department of Anthropology, Washington State University, Pullman, WA 99164-4910; [b]Santa Fe Institute, Santa Fe, NM 87501; [c]Crow Canyon Archaeological Center, Cortez, CO 81321; [d]School of Archaeology, University of Oxford, Oxford OX1 3TG, United Kingdom; and [e]Department of Anthropology, University of Colorado Boulder, Boulder, CO 80302

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[1]To whom correspondence may be addressed. Email: tako@wsu.edu.

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measure in archaeological contexts, and Ortman et al. (18) further those discussions in this SF.

Also of interest is productivity or wealth, which we measure using the central tendency of total house area including storage. (For example, the rear storage rooms common in later houses in the northern Pueblo Southwest are included within the household area.) We use the same proxy to estimate both quantities: one (productivity) emphasizes a system-level characteristic, whereas the other (wealth) focuses on its distillation at the level of the household. Average household wealth is a function of the productivity of the socioeconomic system in which households are embedded. Given the societies analyzed here, agricultural productivity is an especially important component of productivity, although labor productivity due to specialization and technological improvements likely becomes increasingly important through time in many sequences. In this initial, exploratory work, we have not attempted to assess the relative importance of these factors, or of capital accumulation.

How Should Disparities in Residence Size Be Interpreted?

In the United States there has existed a strong positive relationship between floor space per capita and Gross Domestic Product (GDP) per capita as both increased from the late 19th through the early 21st century (19). Americans, at least over the last century and starting from the rather cramped conditions of the 19th century, expanded their interior space as they could afford to. Abundant though often indirect evidence from around the world links house size to either (or both) income and wealth; in many contemporary societies, home equity is the largest component of household wealth (20). Analysis of the US Federal Reserve's Survey of Consumer Finances for 2022 demonstrates that "the median net worth for homeowners was about 38 times the median net worth for renters. Excluding the primary residence equity from net worth, the median nonresidence equity of homeowners was 15 times that of renters" (21). Unmarried men in rural China appear to invest in houses to signal their quality: "males with more social connections, higher income rank, and greater wealth build larger houses" (22).

An established research tradition in archaeology, with early contributions including (23–26), has generally interpreted house size as a proxy for wealth. These studies embrace a broad definition of wealth including its material, embodied (neural and somatic), and relational aspects (27). With some slippage—especially for cultural capital—these can be mapped onto the three forms of capital recognized by Bourdieu (28): economic, cultural, and social, respectively (29). These are differentially inheritable and of varying importance across a spectrum of land-use practices. Kohler et al. (30) present 24 archaeological and ethnographic examples where larger-than-average houses are demonstrated, or inferred, as belonging to households that differentially manifested one or more of these classes of wealth.

In this SF, Ortman et al. (18) provide evidence that residential building size may often be a better proxy for income (a flow of resources to the household per unit time) than for wealth (a stock that may accumulate across generations, depending on mobility and inheritance practices). Income inequality is typically less than or equal to wealth inequality. One would expect both more productive and wealthier households to live in larger residences. All the authors of this SF agree that the Gini values we compute across residential buildings index economic inequality of some kind, and that these Gini coefficients provide a minimal estimator of wealth inequality. When sampling is adequate, wealth inequality was almost certainly not less than, but may have been somewhat greater than, the levels captured by the house-area Gini coefficients we report and analyze. This is also consistent with the relationship between average house-area Gini values for societies of various types, and Gini coefficients computed on other data for these same types of societies: "house-size-based Gini coefficients for hunter-gatherers are slightly lower than those estimated in other ways… [they] are about the same as a series of independent measurements for horticultural societies, but are also lower for agricultural societies" (30). Finally, we have spot-checked house-based Gini coefficients against Gini coefficients estimated from documentary evidence when feasible, generally finding good correspondence. For example, Battistoni et al. (31) use inscriptions from Hellenistic Delos to estimate a wealth Gini of 0.51, whereas our house area Gini for the same time period at that site is 0.54. Also, Alfani and Carballo (32) use Colonial Spanish documents to estimate an income Gini of 0.8 for Aztec Tenochtitlan, whereas our house area Gini for that city, which includes the areas of the royal palaces, is 0.75.

Social scientists have interpreted the somewhat variable evidence for inequality in strikingly different ways, stemming in part from the multidimensional nature of inequality. Max Weber for instance emphasized that divisions formed by class (based on unequal access to material resources), status (social resources), and party (political affiliations) were fundamental. Karl Marx recognized these dimensions as well, while placing particular emphasis on economic power since that, in his view, tends to lead to differences in status and political power. These differing but long-standing emphases remain prominent in contemporary archaeology. Timothy Pauketat for example ref. 33 argues that in Mississippian and historic-period Eastern North America social and political power were more dependent on ability to "consolidate… diverse beliefs and [unify] communities of followers" than on accumulation of material wealth. On the other hand, analyzing the development of leadership in prehistoric and historic Owens Valley of eastern California, Jelmer Eerkens emphasizes the erosion of egalitarian norms accompanying privatization of exotic goods as fundamental to the granting of power to certain individuals to make some decisions for the entire community (34).

Although we agree that such classic distinctions in sources of social power (35) are critical for understanding regional sequences, we center our global approach on differentiation in residence size precisely because this measure is agnostic as to its sources of variation. Whether a residence is larger than another because its occupants hold key ceremonial positions (relational wealth due to position in social network), because it houses more people who collaborate in production (embodied wealth) or because the residents have more productive fields requiring more space for storage (material wealth) is secondary to the fact that each condition entails a larger residence. In fact, we must use a measure that responds similarly to different sources of economic inequality to make seamless comparisons across societies, worldwide, that are based on very different production, distribution, and land-use regimes. As we will see, this focus on residential differentiation offers a new and distinctive vantage point for viewing social development without requiring reference to typological constructs of dubious generality. And yet our approach is completely scalable—just as applicable to regions over short periods (36, 37) and even within sites (38), as to the *longue durée*. Although it has been suggested that determining the "origins of inequality" (along with the origins of agriculture, and the state) emerged as a central focus of Americanist archaeology in the 1960s and 1970s (39), inequality has been bundled into research on the emergence of political hierarchy more frequently than it has been studied in its own right (for an early example see ref. 40). Our conceptual separation of economic from political differentiation will eventually permit viewing their relationship more clearly.

Scope and Structure of the Database

The GINI project brought together over two dozen collaborators with relevant expertise and residence-size data from across the globe (Fig. 1), enabling a new scale of synthesis on Holocene residence-size distributions (41, 42). Papers in this SF examine various aspects of the relational database compiled for the GINI project between 2021 and 2024, from which the files listed in Table 1 are output. The database contains summary information for around four thousand settlements and about 53,000 residential buildings from those settlements. Data collection was more opportunistic than systematic and focused on the archaeological records of preindustrial societies known primarily through their material remains, although some data from ethnographically documented small-scale societies were also included. We focused on times and places where traces of residential buildings are consistently preserved and can be defined and measured through surface survey, excavation, or remote sensing, including lidar. The resulting database contains information for archaeological sites from the US Southwest, Midwest, Southeast, Northeast, and Northwest Coast of North America; the Central and Southern Andes in South America; Britain, Central, Eastern, and Southeastern Europe; Western, Central, Southern, and East Asia; Hawaii, New Zealand, Easter Island, and New Guinea in Oceania; and Northern, Western, Eastern, and Southern Africa. The oldest settlements in the database date from more than 20 kyBP, and the most recent from the mid-20th century. Most however date from 12 to 1.5 kyBP in the Eastern Hemisphere, and from 7.5 to 0.3 kyBP in the Western Hemisphere (Fig. 2). Below, we summarize the contents of the database; for additional details, see the SM in ref. 18.

Continuous data captured for each settlement include its location and area; the "window area" over which residential buildings were observed; the number of residential buildings encountered in that window; the estimated total number of residences; and the beginning and ending dates of the overall occupation and of the associated residences. In addition to these, we collected a variety of contextual variables at ordinal or nominal scales, including nested geographical and chronological groups that capture traditional subdivisions used by experts in various world regions; the presence or absence of fortifications (43); the type of polity in which the settlement occurred, following (44); the position of the settlement within its regional settlement hierarchy (45); the primary limiting factor for increasing production [land vs. labor (46)], measures of collective vs. autocratic governance (47, 48), and the year at which a variety of economic phenomena (plant and animal domestication, metalworking, weights and measures, currency, etc.) first appeared in a given region. Finally, we recorded the source of the information for each settlement, often a publication or archived report, but in some cases direct results of new fieldwork by the contributor.

Importantly, for some regions each "site" record represents a specific phase of occupation at a settlement (e.g., Central Mexico, Western, and South Asia), whereas in others it represents the entire occupation (e.g., Roman Britain). This was an unavoidable consequence of the varying ways information is organized across regional archaeological research traditions and in existing data compilations. To compensate for this, we also captured beginning and ending dates of each residential building at each site. For some regions these duplicate the associated site-level dates, but for others they are distinct and generally more precise. Additional data collected for each residential building include the number of rooms and stories, the total area, roofed area, unroofed area, living area, and area set aside for storage or for animals. We also classified each residential building into a typology that seeks to capture its demographic scale (nuclear family, extended family, multifamily, etc.); and for some contexts we were able to characterize residences along a three-point ordinal scale of construction quality as defined by contributing experts and the distance of a residence to the central place in the settlement (e.g., a major temple, plaza, or crossroads).

Gini coefficients capture aspects of the shape of a distribution, and as such are sensitive to sampling across that distribution. This creates significant issues in cases where the residences are variable in size and only a few have been measured. The largest and grandest buildings tend to be better preserved and are most likely to have been investigated. This can lead to an oversampling of elite residences when only a small subsample of commoner houses have been identified, or undersampling when the largest and grandest buildings are not recognized as such. We attempt to control for these two forms of sampling error by including monumental buildings whenever investigators have interpreted them as including a residential component, and by calculating 80% bootstrapped CI around all estimated Gini coefficients. When this is done, broad CI generally flag cases where we have small sample sizes that include palatial residences.

To facilitate analysis, the co-PIs created several output files drawn from the relational database. Table 1 summarizes these in terms of their rows and columns, the bases for aggregating the data, and criteria for inclusion. The largest (All Records) is a flat file where each row represents a residential building with all of its associated building-level, site-level, and region-level attributes. Three additional files (SiteGiniLevel, SiteGiniStor, and SiteGiniNeib) provide statistical summaries (including Gini coefficients and CI) of residential buildings at the level of the site (a location and a time period), along with

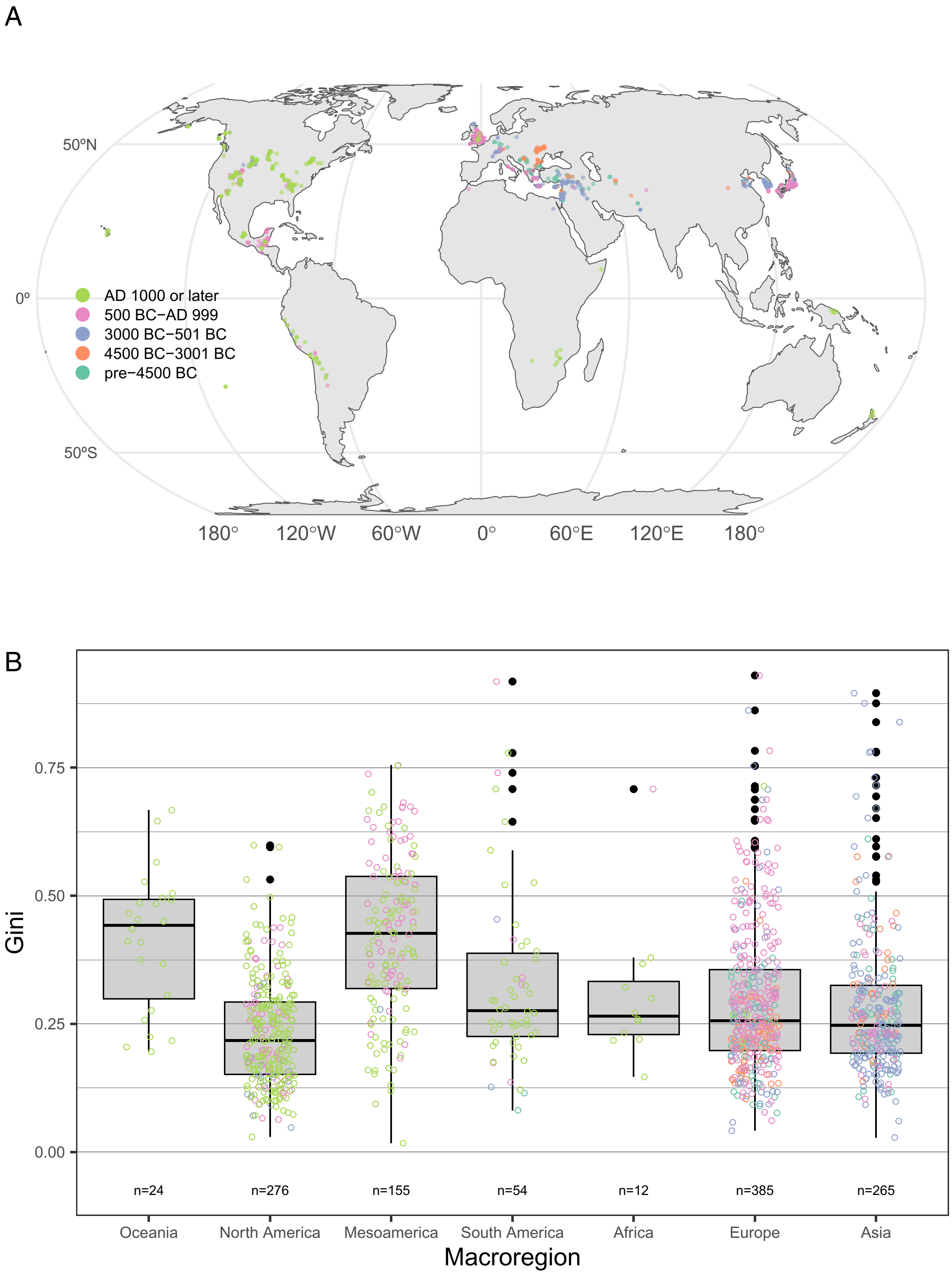

Fig. 1. (*A*) **Spatial distribution of the 1,166 sites in the SiteGiniLevel data with five or more residential units for which Gini coefficients are calculated (equal earth map projection). Five sites with imprecise locations not mapped. (*B*) Boxplots of Gini coefficients for these sites, by macroregion (Bigregion). Colors for periods as in (*A*).**

associated site and regional attributes. Three additional files (SubareaGiniLevel, SubareaGiniNOf, and SubareaGiniWhich) provide summaries of residential buildings by Subarea, time period, and by position of the associated settlement in the settlement hierarchy. The final output (GiniNestedGeog) provides statistical summaries of residential buildings across a series of nested geographical units from the settlement to the region.

We have established a GINI Project repository at https://core.tdar.org/project/496853/the-global-dynamics-of-inequality-gini-project where the files in Table 1 can be found. These files are suitable for replicating the results in this SF,

Table 1. Summary of GINI project output files

File	Rows × Columns	Aggregation fields	Criteria
All records	53,466 × 112	None	None
SiteGiniLevel	1,176 × 75	Site and HousePhase, plus site-level attributes	N > 4 measured residences
SiteGiniStor	411 × 78	Site and HousePhase, plus site-level attributes	StorageArea is recorded
SiteGiniNeib	723 × 81	Site and HousePhase, plus site-level attributes	Residences are assigned to within-site HouseGroups
SubareaGiniLevel	736 × 17	Subarea and HousePhase	N > 4 measured residences
SubareaGiniNOf	612 × 16	Subarea, HousePhase, and NOfLevels	N > 4 measured residences
SubareaGiniWhich	716 × 16	Subarea, HousePhase, and WhichLevel	N > 4 measured residences
GiniNestedGeog	2,350 × 16	Bigregion, Region, Subregion, Subarea, Site, HousePhase	N > 4 measured residences for each scale of aggregation

but the project team continues to find and correct errors in the database, and expand it.

Guide to Papers

We chose not to produce detailed descriptions of residence-size sequences for traditional archaeological regions, though this would be useful. Instead, we intend this SF to be a contribution to world prehistory: all of the papers engage some topic and examine it across the entire database, or at least much of it. We strongly suggest readers begin with this introductory paper, which lays out our main goals, the structure of the database, and how we interpret variability in residence size.

Following that, the paper "Economic inequality is fueled by population scale, land-limited production, and settlement hierarchies across the archaeological record" (45) provides a high-level overview of changes through time in residential disparities by major world regions, employing the version of our database organized by archaeological site (SiteGiniLevel). Fundamental to that paper is the concept of the number of levels in the settlement hierarchy containing each site (NOfLevels), the level within that hierarchy that each site occupies (WhichLevel), and the sum for each site of NOfLevels and WhichLevel, referred to as SA (Social Advantage). SA is strongly positively correlated with polity population for those sites where both can be estimated (45). Applying linear mixed models in a cross-sectional approach to the entire database shows that SA and a variable measuring the degree of land limits on production are both strongly positively related to sitewise Gini coefficients. That paper demonstrates, however, that acquiring or developing domesticated plants does not meaningfully increase average inequality as measured by our proxy within about the first 1,500 years of agricultural life. This may seem surprising given the connection routinely made in texts and broad syntheses between the onset of the Neolithic and increases in inequality, but it is consistent with more recent views, such as those in ref. 10.

That surprise is examined in more detail by Kerig et al. (49), who find almost no indication worldwide for increasing Ginis at the site level across the 4,000 years centered on the development of plant domestication. In most regions, as well as worldwide, the effects of plant domestication for levels of inequality are nevertheless more positive than was the introduction of animal domestication and their use for traction, which tended to slightly diminish inequality in most regions. In only one region (SE Europe) is there a marked effect of these innovations on either the dispersion of Gini values or their central tendency. Here, during the 4,000 years centered on the introduction of animal traction, Gini values became markedly less variable across sites. Clearly any discussion of the effects of the introduction of domesticated plants, animals, and traction on social inequality must take into account these lags and in some cases reversals in the expected direction of change. Possibly our proxy is not as sensitive to subtle trends toward inequality as other categories of archaeological evidence. However, it is also possible that the primary effect of the adoption of agriculture was to stimulate economic and demographic growth, which limited the accumulation of inequality until the resulting population growth led to scarcity of agricultural land (see below). In the best-studied transition to agriculture, in Western Asia, some researchers have found (what they admit to be elusive) evidence for status differentiation preceding what we reconstruct here. This includes differences in body decoration (Natufian), differentially treated burials of children and adults (PPNA), differences in quantities of rare items coming from long distances (PPNB), and the presence of structures at places like Göbekli Tepe (PPNA-B) that seem to call for much organized labor (50).

Bogaard et al. (46) discuss how GINI project researchers assessed land use relating to food acquisition and made the inference for land-limited production. They then show that across this sample of sites, inequalities in both residential areas and storage areas were significantly higher in land-limited than in labor-limited regimes. Evidently, one reason that inequality does not rise immediately on the introduction of domesticated plants or animals, or of traction, is that it takes some time for human population to grow into the available land, creating these scarcities. As noted above, site Gini coefficients generally increase with increases in NOfLevels and WhichLevel, but this increase depends on the presence of land-limited strategies in settlement systems. Comparing the increases in site Gini coefficients across labor- and land-limited regimes and site-size categories enables the critical inference that "flows of surplus sustain site hierarchies in both labor- and land-limited economies, but … these flows are more extended in the latter." The relatively egalitarian character of sites in Chalcolithic Ukraine/Trypillia, Late Neolithic Shandong, medieval Zimbabwe, and the Southeastern United States appears to be explicable by the labor-limited character of their production. On the other hand, some large, land-limited polities (such as those including Teotihuacan and Mohenjo Daro) exhibit moderate to fairly low

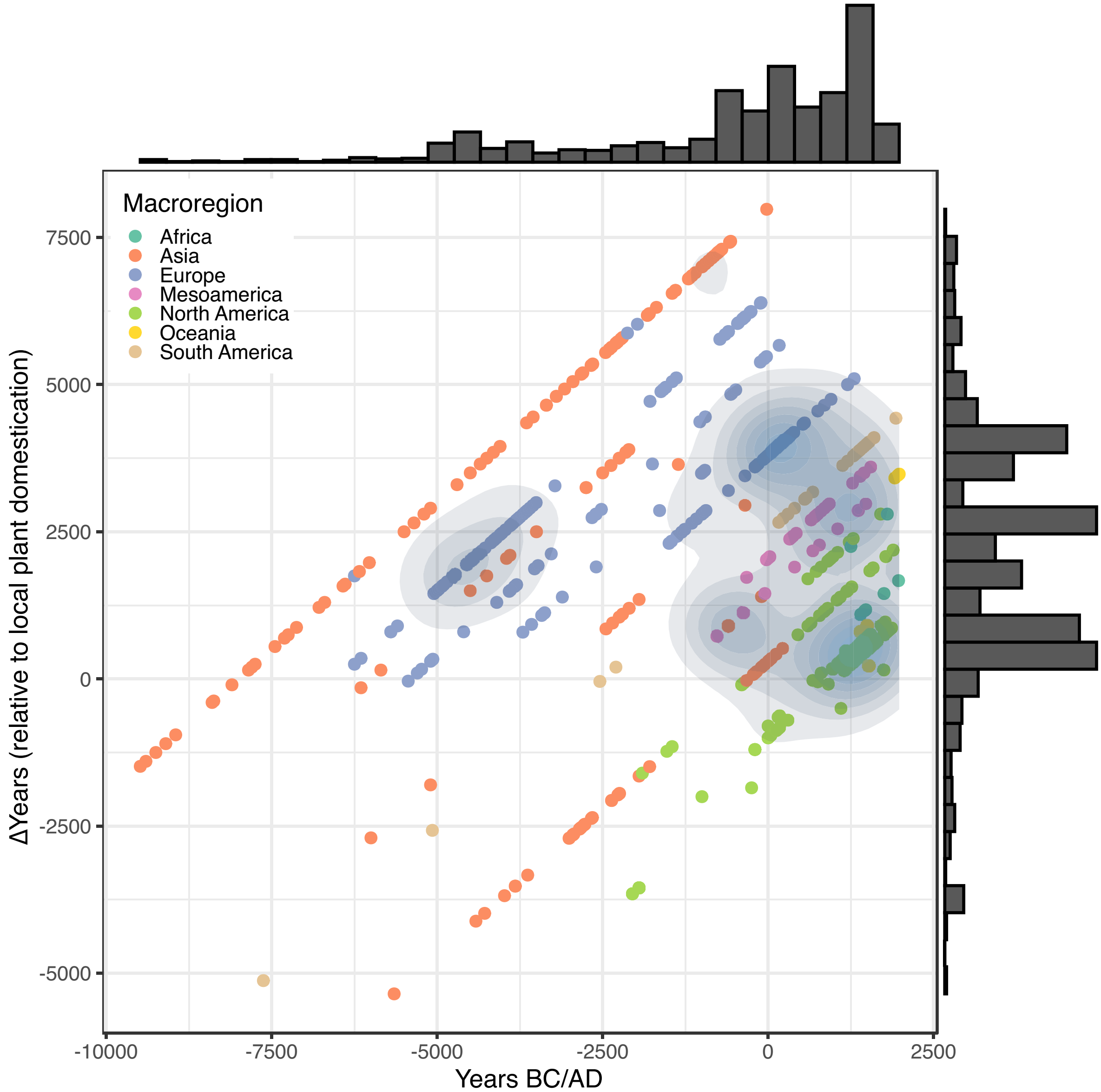

Fig. 2. Temporal distribution (in two currencies) of the 1,166 sites in the SiteGiniLevel data with 5 or more residential units for which Gini coefficients are calculated (24 sites pre-dating 10000 BC not graphed). Linear structures are due to stable mappings between calendar years and Δyears within spatial subsets. Most macroregions have spatial subsets with different times for the onset of plant domestication. Density histograms ignore spatial distinctions.

levels of wealth inequality, modulated perhaps by the nature of their governance.

Feinman et al. (48) examine relationships between site-level Gini coefficients, NOfLevels, and Polity population, finding the expected though rather weak positive correlations. They also explain how the governance variable GovI was coded and report considerably higher (though not statistically distinct according to traditional metrics) Ginis for sites in autocratic (high GovI values) than for those in collective governance regimes (48). By summing NOfLevels and GovI they construct a "Hierarchical clout" variable and demonstrate its stronger positive relationships with sitewise Ginis than for the variables explored earlier. As they note, the highest Gini values in our dataset tend to be in hierarchically organized polities with autocratic governance, mostly in Western Asia, Europe, and South America where the presence of herd animals may also contribute to high Gini values. Feinman et al. emphasize macroregional variability in all these relationships (with North America and Mesoamerica often appearing as outliers) and caution against construction of grand narratives that ignore such variability. Such findings help explain the great importance of North American data and inspirations in the several refusals evident in ref. 10—that complexity entails hierarchy; that transitions to agriculture and to state-like polities were irreversible; that "stages" of human history are generalizable, and so forth: see ref. 51.

The effects of war on housing disparities are explored by McCoy et al. (43), using presence of fortifications as a proxy for conflict or the expectation of conflict. (In a few cases regional experts also coded sites in highly defensible settings as fortified.) Interesting and unexpected patterns emerge: in the earliest sites (prior to 6,000 years ago) residential disparities in fortified sites tend to be slightly less than or equal to those in unfortified sites; most such sites occur in the context of collective governance and labor-limited food production. Later, especially in Western Asia and in contexts of land-limited production and more autocratic governance, fortified sites exhibit higher Gini coefficients than do unfortified sites. The difference arises, the authors suggest, because early fortifications primarily protected the community, whereas later fortifications served primarily to protect property.

Lawrence et al. (52) discuss interactions between housing disparities and persistence of occupation across sites. Do sites with greater inequality tend to be shorter-lived? The opposite, in fact, seems to happen: greater persistence is weakly correlated with more housing inequality, and this relationship grows stronger as settlement systems increase in scale, and is strongest for larger sites in larger systems. Perhaps (the authors suggest) this is due to the increased functional diversity of such sites, or to network effects particularly prominent in such sites, allowing some residents to claim a larger share of the surplus produced by the work taking place in the settlement system.

Thompson et al. examine how inequality is spatially patterned within the largest sites in our database (38). These are mostly cities such as Pompeii and Mohenjo Daro but also include some semiurban and more rural settlements. Regional specialists defined neighborhoods using geospatial modeling, topography, and/or artifact classes. In about three-quarters of the cases analyzed, residences are less disparate at the level of neighborhoods than they are the level of the overall settlement. Clearly, homophily (the tendency of similar people to live near each other) is not a recent phenomenon. Accordingly, perceptions of inequality would have typically been less pronounced for people who stayed within their neighborhoods than for those who experienced the entire settlement on a regular basis. Neighborhoods with more residences generally exhibited more economic heterogeneity (higher Gini coefficients), but longer occupation at the site level did not generate neighborhoods with higher Gini coefficients. Finally, governance impacts neighborhood inequality: sites in more autocratic systems (such as Tikal and Pompeii) tend to have more variation in residence size within neighborhoods than do sites (such as Mohenjo Daro and Tastil) with more collective governance.

If the methods developed in this SF can be successfully applied at the microscale (38) and at the macroscale (45), Green et al. (53) demonstrate their utility at intermediate scales. Specifically they investigate the Bronze Age Interaction Zone from the Mediterranean to South Asia (BAIZ), Classic-period Mayan sites (Mundo Maya), and Britain to examine, in each interaction sphere, the relationship between inequality and economic growth. Despite the differing time scales (BAIZ, 3000 to 1000 BC; Mundo Maya, AD 250 to 1000; and Britain, from Late Iron Age, 400 BC to AD 1100), they demonstrate evidence for sustainable development (that is, increased economic productivity as defined in ref. 18 without increased inequality) in all three areas. In each zone, interaction began with a phase of sustainable development that gave way to periods of extraction and increasing inequality, resembling patterns that Branko Milanovic termed “Kuznets’ waves,” albeit at much longer timescales and with development preceding upticks in inequality, and thus better described as “tides.” In two of these three zones, interaction ended in degrowth, in which both inequality and productivity (growth) decline.

Ortman et al. (18) examine relationships between residence sizes and settlement populations in contemporary real estate data and in the GINI Project database. In the contemporary USA, residence values (a measure of wealth) increase with settlement population, but residence size and count are generally proportional to population. However, in preindustrial societies, residences are generally larger in more populous settlements and larger houses are generally closer to the centers of settlements. In preindustrial settlements the way residence area expands as population grows is similar to the relationship observed in contemporary data for socioeconomic measures like income and GDP. These and other patterns lead these authors to argue that residential building areas capture variation in resource flows (income) and provide only a minimal estimator of variation in capital accumulation (wealth). Ortman et al. also examine the relationship between settlement population and inequality, finding systematic relationships, but with substantial unexplained variation. Finally, they develop a proxy of residential-group productivity (the mean of the logarithm of residence area) to examine relationships between productivity growth and inequality growth across the regional sequences in the GINI Project database. They find every possible relationship between the two growth rates, and that the most fundamental driver of housing inequality growth is the covariance of current residence size with growth in residence size. It is striking to see just how general these relationships are.

Crema et al. (54) consider the potential and challenges of interpreting Gini coefficient estimates of dispersion in residence size at site vs. regional levels. The degree to which site-level Gini coefficients underestimate region-level Ginis is related to the scale of polity and extent of site hierarchy. Observed levels of economic inequality in small-scale societies tend to be consistent across settlements, but in larger-scale heterogeneous polities or hierarchies the spatial distribution of socioeconomic activity and status is more complex, so Gini coefficients tend to be lower in individual sites than they are at the regional level (55). Comparison of site- and region-level Gini coefficients can therefore help to reveal the spatial structure of disparity in residence size. Region-level Gini coefficients in complex societies also require scrutiny, however, as they can be inflated by excavation biases toward larger residences and sites. Pure population-scale effects (53) in the GINI database tend toward zero where at least 100 residences are measured at the site level, though samples biased toward large sites might overestimate such effects.

Limitations to Our Approach

Why not extend the approaches developed here to contemporary societies, thus allowing direct comparisons of economic inequality through time? There are unfortunately several reasons why our approach would not work well in industrialized societies (see ref. 18 for more discussion).

One is the increasing fraction of residences occupied by renters. In such cases, the size of the residence may relate to the income of the tenants, but its value would contribute to the net worth of the landlord. Tenants likely inhabited at least some of the residences in the Roman and Medieval settlements in the GINI Project database, and perhaps those in other contexts as well. An isolated and possibly extreme example (not in our database) comes from Edinburgh where, in 1860, 87% of private residential housing was rented (56). These considerations reinforce the fact that, across societies and history, residence size would be expected to track variation in incomes, and to provide only a minimal estimator of wealth inequality, especially if, as in this example, the ownership of the tenement could not be correctly attributed to the owner of some separate residence.

A related issue is the emergence of multistoried and multiunit tenements. Again, in 1860 Edinburgh, these were the most common residence type and might house 179 people (including 24 children under five) across 5 floors containing 60 rooms, 2 sinks and 1 water closet (56). The GINI Project database only includes multistory dwellings when total floor areas for each residence can be estimated. Some important and well-known structures could not be included. For example, we can only specify residential floor areas for the earliest version of the massive, multistoried great house called Pueblo Bonito in Chaco Canyon; it is impossible to reconstruct how the eventual building (much of which is now missing) was partitioned into residences.

A third issue is how location and quality/cost of construction affects residence value per unit area. In contemporary cities the primary determinant of residence value is location, with land values typically decreasing with distance from the central business district (57). However, transport is faster and cheaper today, allowing individuals to live in suburban areas, where land is less expensive, and to commute to earn urban-center incomes. As a result, residence areas tend to be larger in suburban areas, despite being less valuable per unit area. Ortman et al. (18) show that in the preindustrial world, slow and costly transport attenuated these effects, such that residence sizes declined with distance from settlement centers, as one would expect if they reflected household incomes.

Finally, we acknowledge that the Gini index itself has come under criticism from several directions. As two examples among many, a measure composed of the variance normalized by the second moment has been shown to be more sensitive to extreme values and is also decomposable into inequality within and between subgroups, unlike the Gini index (58). Mejía Ramón and Munson have proposed a very flexible measure they call Local Indicators of Dispersion that honors the relational and subjective judgments at the core of the concept of inequality (59). The raw data we provide can be explored using these and many other proposed quantifications of inequality (54); we have emphasized the Gini index here because of its widespread usage and ready comparability to a large literature. We note that even researchers who are wary of seeking "capitalist dynamics ... [in] prehistory" (not our program in this SF, to be clear) find Gini coefficients to be useful in helping expose how inequalities "in practice" reveal a rich range of social patterns (60).

Next Horizons

Enriched Regional and Local Narratives. In this SF, we develop and present macro models. These should be examined and developed regionally in more detail, considering those additional features of the archaeological record [such as quality of construction and location of residences; differences in artifact distributions; burial goods; embodied characteristics such as height (61), dental, or cranial modification, etc.] that are either present in only small portions of our sample, or were not coded at all. Such regional and local narratives can also address various specific questions such as: How many people live in each house? Do structures likely house nuclear or extended families (62), or some other social unit? Are these spaces shared with animals? Do they include things like workshops or shops? Although the effects of most of these on measures of inequality are controlled for by our research design, these characteristics are of intrinsic interest and their changes through time need to be accounted for.

We also intend to do more with estimates of average productivity. Not only are these intrinsically interesting; they can also help constrain probable local upper limits for Gini coefficients using approaches pioneered by Milanovic and Scheidel (63, 64). Putting our Gini estimates into their Inequality Possibility Frontier (IPF) contexts would reveal how exploitative the distributional system was; indeed, one of our papers argues for nuancing the IPF to take into account the land-/labor-limited distinction (46). In this SF, we emphasize the inequality story, but the performance of these economies, including how much is produced (65) and the resultant standards of living, deserves equal attention. In this SF Ortman et al. begin these analyses (18), which are also continued elsewhere (66).

Measures of inequality can be usefully examined through lenses not used here. In subsistence farming societies especially, climatic variability affecting agricultural production should modulate Ginis by affecting the achievable average surplus per household, providing an indirect but socially meaningful measure of the severity of climatic variability. Moreover, inequality (along with duration of site and structure use) provides a view on mechanisms for intergenerational transmission of wealth—perhaps the most powerful possible view for the prehistoric portions of the record.

Building and Testing Theory across Divides. Debates concerning the causes for economic inequality extend back at least to Jean-Jacques Rousseau. Alfani (67) has recently summarized more contemporary theories by economists (we emphasize those most applicable to preindustrial times) as consisting of several competing but slightly overlapping strands.

Of these, modern growth theory is the best known. It is useful to highlight the work of Oded Galor because of his discussion of the "Malthusian Epoch," extending in his view from 300 kya to 1750 (68). Galor contends that within this epoch all technological advances were turned into population growth, so that standards of living remained stagnant. While the research presented in this SF (and elsewhere, see, e.g., ref. 69) leads us to doubt this claim for most world areas, at least for the Holocene (see for example *SI Appendix*, figure S8 in ref. 45), the mechanisms by which economic inequality is created, according to modern growth theory, remain of interest. In the largest sense its proponents argue that economic growth leads to inequality growth. Work presented here—for example *SI Appendix*, figure S8 in ref. 45—does confirm that there is a weak but positive correlation between the two in most world regions over very long periods, without clarifying the causal direction of the relationship. Ortman et al. (18) also show that productivity is positively correlated with inequality across the archaeological record (figure 3 B and C), but the relationships are weak and only explain a small fraction of the variance. They also show that productivity growth is independent of inequality growth across this record (18, *SI Appendix*, figure S7), suggesting that they change according to distinct processes. Milanovic (70) concluded that Ginis increase with mean income in premodern societies (based on 41 societies mostly in the 18th and 19th centuries, but with samples as early as 330 BC Athens and as recent as India in 1938). Though graphs such as figure 1 and *SI Appendix*, figure S8 in ref. 45 seem to imply monotonic increases through time in both economic inequality and average income or productivity—as also suggested by modern growth theory—the temporal and spatial granularity of our samples in most times and places is not (yet) sufficient to support such assertions. Indeed, our experience has been that where sampling is strongest, there is a great deal of local and regional fluctuation through time in both economic inequality and average income or productivity, and in their relationship [(18) *SI Appendix*, figures S6 and S7].

Alfani and some other economic historians (71) have emphasized the importance of factors outside of the economy, such as catastrophes and political systems, in modulating degrees of inequality. In general our sampling is not sufficiently fine-grained to assess the roles of pandemics, but the collapse of the Roman Empire, and the influence of political regimes, are indeed visible in our data (48). At least in Roman Britain, where our data are most extensive, departure of the legions led to dramatic declines in both living standards, as reflected in residence sizes, and in levels of inequality (53).

A third explanatory strand connects increasing inequality to population growth, "proletarianization," and urbanization. Ricardo (72)—prefiguring a line of reasoning developed here by Bogaard et al. (46)—argued that population growth creates relative scarcities of land and increases the value of its products, favoring increases in wealth and income inequality. Population growth also contributes to progressive loss of land ownership, requiring landless people to sell their labor and its fruits—"proletarianization." Although this has been studied primarily in early modern Europe, it is relevant to preindustrial economies wherever the Domestic Mode of Production (73) was becoming enriched with market involvement, household specialization, and the increased production for exchange (74) that accompany increased functional specialization of settlements and growth of settlement hierarchies. The analysis in ref. 18 finds a positive association between levels of agglomeration, reflected in the mean-log settlement population for various regions and time periods, and housing inequality (figure 3A), explaining however a small fraction of the variance in inequality. Also, according to the analysis in ref. 45 the appearance of settlement hierarchies, led by increasing scarcities in land due to population growth, is a main motor of increasing economic differentiation: higher Gini coefficients are strongly connected to larger settlements in higher levels of the site hierarchy. (Growth of settlement hierarchies likely coevolves with increasing economic differentiation.) This echoes in important respects the account given by Kuznets (75) of the key role of urbanization in widening the income gap in Europe and the United States during the first Industrial Revolution, although the processes we recreate took place over millennia rather than a century or two. Milanovic also found a significant positive association between urbanization rate and Ginis in 41 premodern societies (70).

Using its growing interest in inequality and economic growth as a bridge, archaeology can thus seek greater interaction with economics in building narratives of what happened in history, and in teasing out causes of the dynamics revealed. Of course an archaeology centered on documenting economic inequality and trying to understand growth must also consider their human costs and consequences, abundantly discussed in ref. 76. Many people have a deep conviction that too much economic inequality is morally unacceptable, but the grounds for this belief, and opinions on how much is too much, appear to be many and varied. Philosopher T. M. Scanlon argues that "there is no general principle specifying the pattern that the distribution of income and wealth should take. Whether a distribution of income and wealth is just depends on the nature of the institutions that produce it, and inequalities in income and wealth are fair if the institutions that produce them can be justified in the proper way. Justification of institutions is a complex matter, depending on empirical facts about the consequences of various economic and political arrangements in a given setting" (77). Clearly, in any quest for the *moral* implications of economic inequality, the sorts of documentation we begin to set out here will be only the first and not even the most important step. In the long run archaeology may be more useful for assessing the *pragmatic* implications of varying levels of inequality for innovation, wealth creation, human health, and well-being.

Our Goals

These papers open conversations on inequality, wealth, and social power in ways that facilitate their examination across some of the near-sacred boundaries of disciplinary discourse. These include history vs. prehistory; industrial vs. preindustrial societies; and capitalist vs. noncapitalist systems. It should not be assumed that because our goal is to monitor economic differentiation that we believe that maximizing wealth was a pre-eminent goal of the populations studied here, as it may well be for many in contemporary industrial, capitalist societies with corporations (78). That is one of the things to learn more about using these approaches. We also hope that our example will encourage discussion and analyses of inequalities that do not depend primarily on qualitative or ordinal distinctions: It's time to move beyond problematic taxa such as "egalitarian societies." We further hope to stimulate empirical approaches to archaeology on a global scale that are vanishingly rare today—recent exceptions (79, 80) are all too easy to enumerate. We agree with Holtorf (81) that "humanity on Earth needs panhuman solidarity, trust, and collaboration to be able to face enormous global challenges." Holtorf argues, and we agree, that the heritage community must develop "new understandings of cultural heritage that … are predominantly about … change and transformation," presenting humanity as global beings without regard to national boundaries.

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