Changing Social Inequality From First Farmers to Early States in Southeast Asia

Mattia Fochesato
Dondena Centre and BIDSA, Bocconi University, Via Röntgen 1, Milan 20136, Italy

Charles Higham
Department of Archaeology, University of Otago, Dunedin 2014, New Zealand

Amy Bogaard
School of Archaeology, University of Oxford, 1, South Parks Road, Oxford OX1 3TG, UK
Santa Fe Institute, 1399 Hyde Park Road (Cowan Campus), Santa Fe, New Mexico, USA

Cristina Cobo Castillo
University College London, Institute of Archaeology, 31–34 Gordon Square, London WC1H 0PY, UK
National University of Singapore, Department of Southeast Asian Studies, Singapore

*Corresponding author: Mattia Fochesato. E-mail: mattia.fochesato@unibocconi.it

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Abstract

When the first rice farmers expanded into Southeast Asia from the north about four thousand years ago, they interacted with hunter-gatherer communities with an ancestry in the region of at least 60 millennia. Rigorously dated prehistoric sites in the upper Mun Valley of Northeast Thailand have revealed a 12-phase sequence beginning with the first farmers, followed by the adoption of bronze and then iron metallurgy leading on to the rise of early states. On the basis of the burial rituals, involving interment with a wide range of mortuary offerings and associated practices, we identify through computing the values of the Gini Coefficient, at least two periods of intensified social inequality. The first occurred during the initial Bronze Age that, we suggest, reflected restricted elite ownership of exotic valuables within an exchange choke point. The second occurred during the later Iron Age when increased aridity stimulated an agricultural revolution that rapidly led to the first state societies in mainland Southeast Asia.

Significance statement

This is the first time that an exploration of social change, measured by means of the Gini Coefficient, has been applied to a 2,500-year cultural sequence in Southeast Asia. The results indicate pulses of elevated social inequality from different stimuli, some transient but the last, due to an agricultural revolution consequent to climate change, enduring.

Main Text

Introduction

The calculation of Gini coefficients has identified a marked increase in social inequality in Western Eurasia related to a transition from labour-limited to land-limited economies[1]. Related projects have provided similar insights by comparing post-Neolithic Western Eurasia to North and Mesoamerica[2]. Here we identify similar changes over a period of 2,500 years in the Upper Mun Valley of Northeast Thailand. This cultural sequence has the very rare advantage of being dated by multiple radiocarbon determinations, each refined through Bayesian analysis such that in some instances, cultural changes can be identified on a generational basis. Derived from four sites, there are twelve phases (Fig 1). Neolithic 1 represents the initial settlement by incoming rice farmers in the 18th century BC, found at the key site of Ban Non Wat[3]. Neolithic 2 began in ca. 1250 BC and ended with the first of five Bronze Age (BA) phases: BA1 1050-1000 BC[4], BA2 1000-900 BC, BA3 900-800 BC, BA4 800-700 BC and BA5 700-420 BC. The four Iron Age (IA) phases ended with the transition into regional states in the 6th-7th centuries AD [5-6] and are dated IA1 420-100BC, IA2 200 BC-AD 200, IA3 AD 200-400 and IA4 AD 300-500. The final phase dates from AD 500 and is described as the early historic period when early states were forming. All phases have provided human burials, the mortuary rituals being the data we deploy in order to assess social inequality. These mortuary data are unique in Southeast Asia. There are 540 intact adult human burials, a great variety in the quality and quantity of grave goods, recovered from constantly evolving approaches to the layout of the interments. We find dispersed graves, nucleated groups of burials, and

residential burials cut through house floors. For vital periods of this sequence, there is also an unrivalled database of environmental evidence, and details of the agricultural regimes.

The Upper Mun River region controls the east-west passage across the Petchabun Range, linking the Central Plain and coast with the elevated Khorat Plateau (SI, Fig. S1). Occupants not only had privileged access to exotic goods, but also commanded rich salt deposits. Throughout the period covered, a changing catalogue of desirable rarities sourced west of the Petchabun pass were incorporated into mortuary rituals. Marine shell came in the form of cowries, beads, bangles and earrings. Marble was worn as earrings and bangles. Copper from mines in the Khao Wong Prachan valley has been identified in the earliest Bronze Age graves[7]. With the opening of maritime trade routes in the later first millennium BC, marble and shell gave way to bronze, agate, carnelian, glass, gold and silver ornaments, as well as the introduction of iron technology. To the east, the Mun River was a natural conduit for the rich copper output from Vilabouly in upland Laos.

The first farmers settled the upper Mun Valley in the 18th century BC, bringing with them domestic rice, pigs and cattle. Through archaeobotanical investigations looking at macroremains in two of these sites, evidence of rice and associated weed species allowed us to reconstruct farming systems dating from the transitional Neolithic - Bronze Age period to the Late Iron Age. Rice cultivated in rain-fed fields was a component of the subsistence base until a sharp deterioration in the strength of monsoon rains from ca. AD 200. This period of relative aridity then stimulated an agricultural revolution, documented in the construction of moat reservoirs that fed irrigated wet rice fields, ploughing in place of hoe cultivation, interment of the dead in rice-filled graves accompanied by iron sickles, and a surge in infant mortality that probably reflects environmental degradation involving the spread of malaria and other aquatic pathogens.

We estimate the Gini coefficients for each of the twelve phases, implementing recently developed statistical methods[8] to tackle issues of comparability and precisions of estimates computed across different samples and population sizes, and units of wealth ownership. These methods allow us to enrich the understanding of the ancient Northeast Thailand cultures by providing an unprecedented quantitative assessment of the changes of social inequality in the region across 2,500 years. In particular, the Gini coefficients permit us to precisely quantify the link between the aforementioned changes in environmental conditions and farming systems and the increase of wealth inequality. In addition, we show that these quantitatively assessed patterns of inequality resemble those found by other projects in Western Eurasia[1] and might constitute a methodological and substantive basis for future contributions on ancient global social inequality.

The sites

Ban Non Wat is a moated settlement with the longest sequence in Southeast Asia that covers the initial Neolithic to the end of the Iron Age. The Neolithic 1 and 2 cemeteries involved un-nucleated burials that covered much of the excavated area (SI, Fig. S2). There are too few Bronze Age (BA) 1 burials for analysis, but they were located in a relatively tight group. With BA2 we encounter discrete rows of burials that present as a very wealthy elite enclave. BA 3A and B form a tight cluster. BA 4 burials fall into four probable groups, all deemed contemporary, that comprise rows and columns in which the

graves were placed head to toe. BA5 graves were grouped in a cluster that merged by horizontal stratigraphy into a seamless transition into Iron Age (IA) 1 graves that comprise two groups distinguished by the orientation of the body, one with the head to the north, the other to the south (SI, Fig S2). Later IA graves at this site are sparse. Ban Lum Khao has a small number of Neolithic 2 burials that gave way to an extensive cemetery of BA 2 graves, the ceramic typology of which matches that of the BA 2 at Ban Non Wat[9]. There are very few IA 1 burials at Noen U-Loke. During IA 2 and 3, the dead were interred in tight clusters on a chequerboard pattern, that gave way in IA 4 with rows of graves[10]. At Non Ban Jak these same rows were found during IA4, but at this site, the preservation of house walls and floors reveals that the dead were interred within residential rooms[6] (SI, Fig. S2).

The long chronological sequence at Ban Non Wat also allowed for an examination of any changes in the farming systems and the plant-based diet. Ban Non Wat samples dating to the Neolithic-Bronze Age transitional period provided evidence of a predominantly rice-based diet and a dryland farming system. In order to differentiate between dry and wet rice farming, weeds found in association with rice were used as a proxy as these are often found in specific habitats or ecologies. The reliance on rice persisted until the Iron Age at Ban Non Wat with no major added component from any other economic crop including pulses. However, changes in the farming system took place during the Iron Age and by the Late Iron Age, bunded wetland agriculture was in place. Wetland rice is at least twofold to threefold more productive than dry rice although more labour intensive[11, 12]. Investments in rice cultivation are believed to be responsible for demographic expansion, such as in the Gangetic Plains of India and in the Upper Mun River Valley sites.

Thirty-eight archaeobotanical contexts were analysed at Non Ban Jak which again showed rice being the most important economic crop. Half of the contexts were made up of more than 50% rice, including one which was solely comprised of rice remains. Cotton boll fragments and spindle whorls have also been identified in Non Ban Jak signifying craft production. The rice was cultivated under wet conditions and the presence of green algae (*Chara zeylanica*) indicates permanent wet fields or irrigation. It is evident that at Non Ban Jak, the population had specific roles, including farmers and craft specialists.

Methods

Although the social organization represented in each sample has been published, no systematic measurement of pulses in inequality throughout the 2,500 years has been undertaken. By initially taking the frequencies of just one exotic item found over time, however, there are intriguing implications. For the Neolithic and Bronze Age sequences, the average number of exotic marine shell bangles reveals an overwhelming increase during the BA2 and 3 phases (SI, Fig. S3). In the case of the IA, we find a similar sharp rise in the number of exotic bronze ornaments during IA 3 at Noen U-Loke, followed by a decline in the latest IA contexts (SI, Fig. S3). In this study, we have applied the values of the Gini coefficient (GC) to cultural phases over the entire 2,500-year sequence in order, for the first time, to identify and if possible, explain instances of a rise in social inequality over the longue durée. The great strength of enlarging upon such findings through quantitative estimates, such as the Gini coefficient lies in the fact that we involve

all artefacts placed in each individual grave. We have divided these into six groups: pottery vessels, artefacts that are exotic, ritual and useful, food remains and the number of bronze or iron artefacts.

There is the perennial issue of adjusting raw numbers to take into account the potential value of an item in the prehistoric mind. Thus, should a useful spindle whorl have the same status as a gold bead necklace? Although acknowledging the potential of modern bias, we have adjusted numbers to take this problem into account. For example, a bronze artefact, agate pendants and exotic shell bangles have been multiplied by a factor of 5, a gold or silver item by 10, iron by 3 and marble and shell earrings by 2. A list for each ~~site~~ item is given in the SI, Table S1.

We measure the extent and change of inequality across site and phase by estimating the GC, an indicator that is widely used to describe the concentration of an asset (or a sum of) in a population. It is measured as one half the mean of the wealth difference across each pair of units in a population, divided by the average wealth in the population and it assumes values between 0 (complete equality) and 1 (complete inequality). Its capability of summarizing the extent of concentration of all the burial artefacts across all the population units in each phase makes it a key method for our aim of reconstructing the patterns of change of social inequality across 2,500 years.

As it is often the case with archaeological or historical sources, we also acknowledge the presence of methodological challenges that could potentially hinder our capacity to draw effective conclusions or make meaningful comparisons across coefficients estimated at different space and time. In a recent contribution, co-authored by two of the current authors, five methodological issues, arising when inequality is measured from archaeological datasets, were singled out and a statistical procedure was set up to account for them[8]. These issues are: 1) the bias due to small sample size, 2) the different population size across cultures, 3) the comparability of the GC estimated on different wealth assets (house area and grave wealth), 4) the comparability across GC estimated on individual or household wealth and 5) the lack of individuals with no wealth.

The estimation of the GC for our sites presents challenges 1, 2, and 4, and we briefly describe here how we tackle them following Fochesato et al.[8] (in the SI we show the validity of their method to correct our GC). First, we acknowledge that our excavations might only be a sample of the entire population. Using multiple archaeological datasets, the authors have found that the GC computed on a subsample is on average larger than the one computed on the entire population, with the discrepancy between the two declining steadily as the subsample becomes larger[8:861]. They also showed that the relation between the upward bias and sample size is similar across different datasets and here we found that this result holds true when tested on our current dataset (SI, Section S2). This suggests that their method can be used to correct our GC.

Archaeological datasets reporting burial wealth are compiled at the individual level, as females and males were usually buried in single graves with their own rituals. However, wealth distribution is usually assessed between households, the basic population units that shared and used assets. In [8:856], the authors used the demographic information of buried individuals in large archaeological datasets and, through different hypotheses about assortment practices, they reconstructed hypothetical households to gauge the ratio of between-households to between-individuals inequality. We have replicated their exercise and found a similar ratio to the one published in reference[8] (SI, Section2). We

have used this ratio to adjust the GC as if they were computed on household wealth. A final issue regards the size of the whole population, which might have been different across sites and might have affected the degree of social differentiation in the society. Using the GC computed at different levels of population entities within the same archaeological dataset, a positive relationship between inequality and population size has been found. We adopt this statistical summary to rescale all our GC values to the same population benchmark (SI, Section S2).

Differently from Fochesato et al.[8] we have not adjusted our coefficients to take into account different wealth assets, as our data include only one type of wealth, i.e. burial artifacts, nor do we adjust for the potentially absent individuals with no offerings, as each phase/site includes individuals with zero wealth.

Because of the nature of the adopted method, all the adjusted GC are lower than the unadjusted ones (Table 1). They are, on average, 9% less than the unadjusted GC and the decrease ranges between 8.7% and 9.2% (SI, Table S4). As the signs and the relative sizes of the adjustments are similar across the cases, we conclude that the method, which improves the reliability of the estimates, does not alter the relative hierarchy of the sites/phases with respect to their social inequality. Nor it reduces the heterogeneity (and richness) of the information provided by the dataset. In fact, the standard deviation ~~of~~ across all the adjusted GC is 0.112, even slightly larger than the standard deviation ~~of~~ across all the unadjusted ones (0.102).

In Figure 2 we plot the adjusted GC by site and phase, and the time trend of inequality across the whole period estimated through a second degree local polynomial regression. The time trend detects rising trends of inequality towards the end of the Neolithic reaching a peak during the early Bronze Age. Then, inequality decreased in the subsequent centuries and increased afterwards, reaching another peak during the later Iron Age. In Figure 3 we summarize the measure of inequality by the three main phases in our dataset. Figure 3 shows that, despite a large within-phase variation, inequality during the Neolithic phase was significantly lower than during the Bronze Age (p-value of the Welch's t-test of the mean difference equal to 0.072) and Iron Age (p-value 0.073), (SI, Table S4).

Results

During both Neolithic phases at Ban Non Wat, exotic items were rare almost to the point of being absent. For the initial Neolithic, locally made pottery vessels dominated mortuary offerings. One young male did stand out on the basis of the number of ritual bivalve shells, two cowry shells and pig bones, but the GC is low and there is no evidence for inequality. The same situation is found for Neolithic 2 burials. There are insufficient burials for the ensuing first Bronze Age phase, although continuity is seen in similar forms of ceramic vessel, and there was an undoubted increase in the quantity of exotic ornaments, complexity of ritual seen in one woman being interred in a boat-shaped coffin and the first presence of copper-base axes.

With BA2 the situation changed dramatically. Virtually all adults and infants were interred with wealth unparalleled for the period in Southeast Asia. The dead were interred in rows, wearing multiple marine shell and marble ornaments, as many as 80 decorated ceramic vessels in a wide variety of new forms, and often with copper-base axes and rarer

metal ornaments. Some adults had been disinterred and then reburied, and graves were far bigger than was necessary to contain the body. Smaller excavations elsewhere on this site have revealed BA2 individuals who were markedly poorer in every respect. It is suggested that there was a burial place for a social elite and another for the less-well endowed. The upshot of such a uniform degree of wealth among the elite, is that the GC for this group fails to distinguish social inequality among its members.

We have therefore combined this elite group with a contemporary cemetery from the nearby site of BLK. Here again the dead were laid out in rows, with a subset of pottery vessels virtually identical with those from Ban Non Wat. However, the mortuary offerings at BLK were markedly fewer and the GC is a modest .457 (SI, Table S5). When combined, the GC soars to .657, the highest we record for any sample. We conclude that there is supporting evidence for a sharp rise in social inequality during the early Bronze Age, also detected by the rising time trend shown in Figure 2. At Ban Non Wat, this was sustained with BA3 and BA4 with GC values of .542 and .603 respectively, before falling with the final phase of the BA (.350).

At Ban Non Wat, the late BA cemetery merged with that of the initial IA, the latter comprising two nucleated groups containing 70 complete adult burials. New exotic ornaments now comprised very rare items of glass, agate and carnelian of ultimate South Asian origin, and a marked increase in the number of bronzes. There was also a modest number of iron ornaments, weapons and tools, including knives, spears and socketed hoes. Fish were often placed in the graves. The GC rose to .433, slightly higher than during the preceding BA5 phase.

There were insufficient later IA graves at Ban Non Wat to provide reliable data, so we move about 2 km to the west, to the moated Iron Age settlement of Noen U-Loke. Here, there are three IA phases labelled IA 2, 3 and 4. There was a steep rise in the number and variety of mortuary offerings that was particularly notable with IA 3. Now, graves were filled with rice. Compared with the nucleated set of graves seen at Ban Non Wat during the initial IA, graves during IA2-3 formed tight clusters on a chequer-board layout (SI, Fig. S2). Some individuals, particularly during IA3, were spectacularly wealthy, one man being interred with 224 bronze ornaments, agate pendants, glass beads, and gold and silver ear discs. Another man wore four bronze belts, and a man beside him was accompanied by a pottery vessel containing a socketed iron ploughshare. Women, too were buried with impressive exotic ornaments including gold and agate beads and silver bangles. A new rising trend of social inequality is detected during the IA (Figure 2) when the GC rose to .557 in IA 3.

IA 4 at both Noen U-Loke and the third significant site, Non Ban Jak saw a further change in burial practice, with the dead now interred within the rooms of domestic houses. Although less spectacularly endowed than during IA3, the GC for IA4 at Noen U-Loke rose to .608, and that at the smaller nearby site of Non Ban Jak, the GC is .477. Significantly, two more iron ploughshares were found at Non Ban Jak, but not in graves.

Discussion

The lack of any social distinctions in the Neolithic graves of Ban Non Wat may be compared with three other Neolithic settlements: Ban Kao[13],Khok Charoen[14] and Khok Phanom Di[15].The dead at Ban Kao were interred in a diffuse group with pottery vessels

and stone adzes, but very few exotic ornaments. Their GC is the lowest we encountered at .310 (Table 1). At Khok Charoen, we again find that pottery vessels predominated, with a scattering of bivalve shells, stone adzes and shell ornaments. The GC is .435. Khok Phanom Di is a special case with its seven mortuary phases. Phases 2-4 comprised superimposed clusters on a chequerboard pattern (SI, Fig. S2), in which the dead were accompanied by fine pottery vessels and on occasion, an impressive number of shell beads. Most were sprinkled with red ochre and some women were associated with clay anvils for shaping pots, and burnishing stones. The GC for these three phases is .329. However, with the phase 5, there was a spectacular burst of mortuary wealth with a woman potter interred wearing over 120,000 shell beads, two shell discs, a shell bangle, and superb pottery vessels. This same phase also included a male and three infants of very great wealth. There was no interdict on social elitism in this Neolithic site, situated as it was on an estuary we see as a central node in an extensive riverine and coastal exchange network.

Two sites beyond the upper Mun Valley provide comparanda for the Bronze Age. Non Nok Tha is located remotely in the northern Khorat Plateau. Bronzes were cast there, but few were found with the dead[16]. The GC is a modest .478. The 42 intact burials at Nong Nor were found in two groups. Although some individuals were associated with exotic jade, carnelian and serpentine jewellery, and bronze and tin ornaments were sporadically worn, none matched in wealth the elites of Ban Non Wat. The GC for this site is .510.

We have identified three episodes of greatly increased social inequality during the 2,500-year sequence. The first occurred ca 1800 BC at the Neolithic site of Khok Phanom Di, the second ca 1100-800 BC at Ban Non Wat during the early Bronze Age, the third ca AD 200-400 during the later Iron Age (the last two episodes are also captured by the peaks of the time trends of social inequality shown in Figure 2). These raise the fascinating issue of whether or not there was a tendency in Southeast Asian rice farming communities, for aggrandizer individuals or specific kin groups to seek social prominence. Khok Phanom Di was located on an exchange choke point, the estuary of the Bang Pakong River. Graves representing about 20 generations were found in a stratified sequence, a unique finding virtually world-wide. During the first 12 generations, there were rare instances where an individual was interred with far more than the norm in terms of personal ornaments. A specialist female potter was then interred in a grave larger than necessary to contain her body, under a stack of clay preforms for making pots, covered in red ochre and adorned with a spectacular assemblage of exotic shell jewellery. Her clay anvil for shaping pottery vessels and two burnishing stones in a shell container lay beside her right ankle. Two infants interred on either side of her grave were also extremely wealthy, one also under clay preforms, with thousands of shell beads and a miniature clay anvil beside her right ankle. It does not take a leap of imagination to visualize a mother daughter relationship, the 18 month old infant already learning how to make ceramic vessels. A very wealthy male was also present. Intriguingly, a headless male buried in a shallow grave adjacent to the wealthy matriarch was accompanied by just two pots. This occurred as the environment changed rapidly to marine conditions as the sea level rose higher. We suggest that this transformation reflected her standing as a highly skilled artisan who fed her output into a major exchange network. Nor was she unique to the site.

During the ensuing phase, very wealthy women were found interred under the floor of a building raised on a platform.

The introduction of copper-based artefacts into Southeast Asia took place towards the end of the 2nd millennium BC as part of the southward expansion of the necessary technical knowledge, a move that almost certainly involved long distance exchange and the movement of copper prospectors and founders[17]. At least three copper sources were identified and exploited, one of which was located on the western side of a pass over the Petchabun range that linked Central Thailand with the upper Mun River valley. Ban Non Wat lies on a choke point for the exchange not only of copper-base items, but also marble and marine shell. On the economic foundation of dry rice farming, the raising of domestic pigs and cattle, and hunting and gathering, we suggest that it was by securing control over the ownership of and access to these exotic goods, including the novel and remarkable first metal, that an aggrandizer segment of Ban Non Wat society secured elite status. This was not confined to this one site; we know of rich elite graves at the nearby site of Ban Prasat. However, at more dispersed sites such as Non Nok Tha without control over exchange routes, all the Bronze Age dead were comparatively poor.

Nor was the early rise of a social elite at Ban Non Wat permanent. It endured for about eight generations before there was a sharp decline in mortuary wealth as doubtless, bronze became more readily available to the point that bronze bangles were being cast on site employing a novel technique of multiple moulds.

The sharp rise in elite wealth during the later Iron Age is best measured in the proliferation of bronzes and exotic glass, carnelian, agate, gold and silver ornaments. There may have been multiple stimuli, not least the evidence we have for salt production on an industrial scale that, like land, was a potential source of material wealth that could be monopolized and passed between generations. Unlike the situation during the preceding early Bronze Age, however, we cannot invoke an exchange choke point in this case because numerous large sites ringed by moats are found throughout the Mun River valley. Multiple new factors have been identified to explain the Iron Age case of increased social inequality. It occurred when the strength of the monsoon rains faltered and there was a need to maintain rice productivity.[18] The onset of aridity was contemporary with the construction of moat/reservoirs. These were linked by distributories to banked permanent rice fields. At this same juncture, iron ploughshares replaced hoes, and domestic water buffaloes were corralled within the settlement of Ban Non Wat. These remain the principal source of tractive power for ploughing rice fields. Dryland weeds that dominated until ca AD 100 were replaced by species adapted to wetlands[19]. During the period of transition, we find that both dryland and wetland farming systems were practiced concurrently and eventually irrigated wetland rice prevailed. We conclude that there was a transition from labour-limited dry rice cultivation by hoe to land-limited wet rice plough-based farming as climatic conditions deteriorated, a situation that advantaged those owning the best irrigated land. One manifestation of increased rice production and the wealth it represented is seen in the deposition of large quantities of grain in graves. As a consequence, also wealth inequality increased. For example, our estimations allow us to compare the GC in the labour- limited Ban Non Wat in BA5 with the ones in the two closest and temporally subsequent land- limited sites, Noen U-Loke (IA3 and IA4) and Non Ban Jak IA (the sites are only 2km apart from Ban Non Wat). Our estimates show that, after the shift from labour- to land- limited cultivation, wealth

inequality increased on average of more than 50% (Table 1) . We conclude that this mirrors our results from an earlier study in western Eurasia, where social inequality expressed in the GC rose, although to a larger extent, in tandem with the rise of land-limited farming[1:1138].

In Southeast Asia, the impact of this agricultural revolution was profound. The creation of wet rice fields generated a habitat riven with dangers to human health. It would have encouraged the proliferation of malarial mosquitoes. The many fish and shellfish found in the middens at Non Ban Jak harbour deadly pathogens, as does regular proximity to domestic farm animals for those wading through waterlogged fields to transplant, weed and harvest rice. This had a serious impact on health, particularly for women, seen in the doubling of infant mortality with the adoption of wet rice farming, many of the dead being pre-term or neonates. This agricultural revolution was also seminal to an astonishingly rapid rise of state societies during the 6th century AD. The archaeological signature in the upper Mun Valley was the trebling in area of Muang Sema, with the construction of a Buddhist monastery and epigraphic evidence for a royal lineage[20]. Both in Northeast Thailand and adjacent Cambodia, as might be predicted, we encounter a society that comprised wealthy elite landowners and tied agricultural labourers ancestral to the civilization of Angkor[21]. Our study has revealed in this last case, a permanent rise in social inequality stimulated by adaptability to climate change. The two prior instances have incorporated more nuanced inputs, that had in common a human tendency towards indivualising behaviour by social aggrandizers.

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Figures and Tables

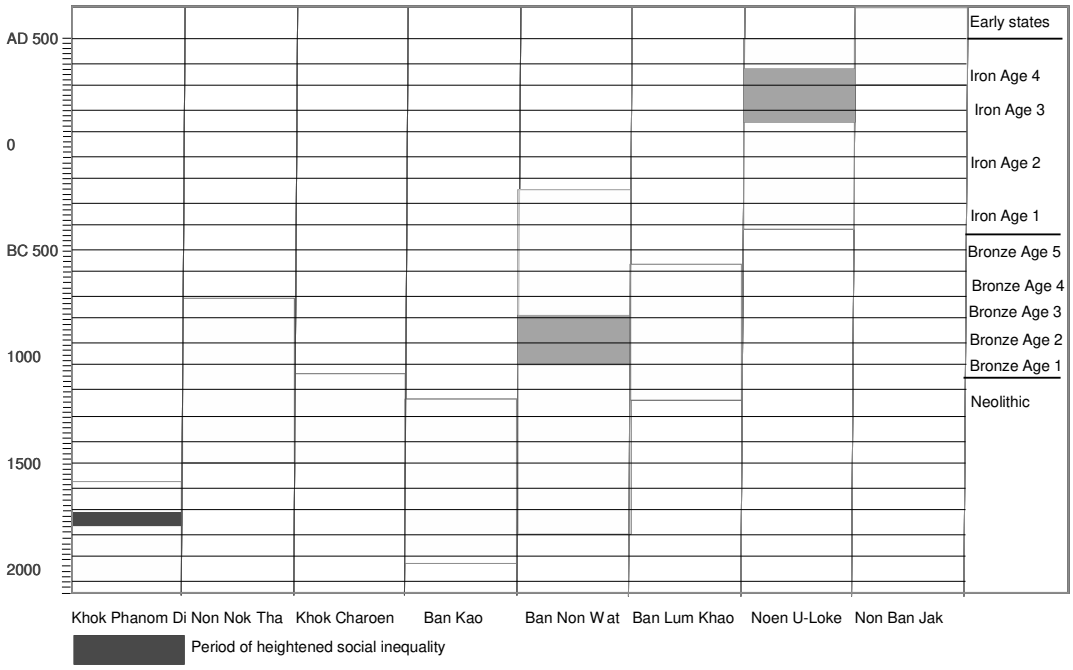

Figure 1. The chronological relationships between the sites under discussion, showing the pulses of increased social inequality

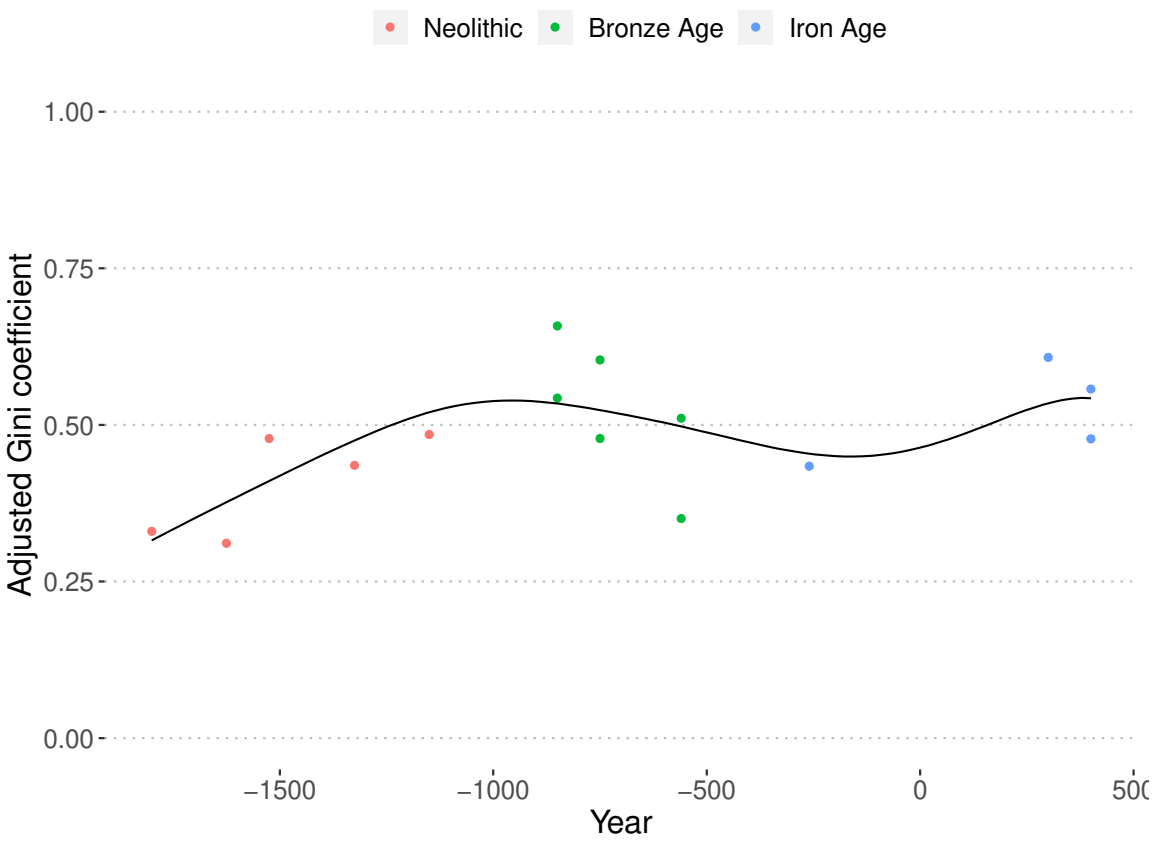

Figure 2 Adjusted Gini coefficients over time and time trend. The solid line shows the time trend estimated through a second degree local polynomial regression with a kernel smoothing bandwidth parameter equal to 400 years. The light grey area delimits the 95% confidence intervals of the time trend. Dates are midpoints of the year intervals by phase-site shown in Table 1. Year "0" indicates beginning of AD/CE. Source: Table 1.

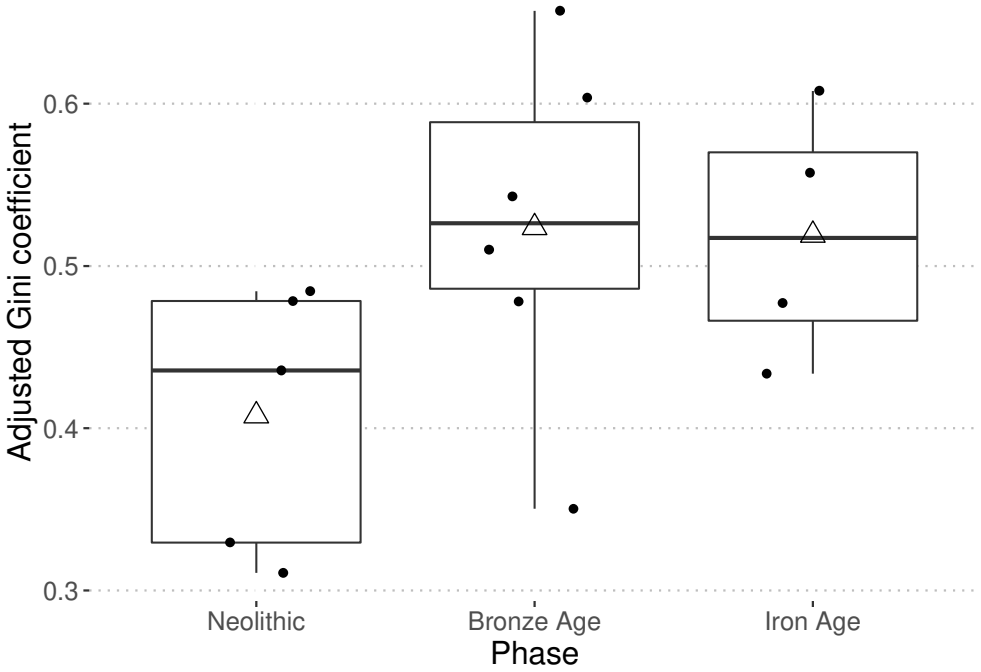

Figure 3. Adjusted Gini coefficients by phase. The boxes show, for each phase, the 95% confidence intervals of the median Gini coefficient (shown by the black line within the box). The triangles indicate the mean wealth inequality by phase. Source: Table 1.

Site (1)	Phase (2)	Dates (3)	Sample size (4)	Unadj. Gini coefficients (5)	Adj. Gini coefficients (6)
Ban Kao	Neolithic	2000-1250 BC	27	0.340	0.310
Khok Charoen	Neolithic	1500-1150 BC	22	0.477	0.435
Khok Phanom Di	Neolithic	2000-1600 BC	53	0.363	0.329
Ban Non Wat	Neolithic 1	1800-1250 BC	14	0.524	0.478
Ban Non Wat	Neolithic 2	1250- 1050 BC	26	0.532	0.484
Ban Non Wat /Ban Lum Khao	Bronze Age 2	900-800 BC	43	0.724	0.657
Ban Non Wat	Bronze Age 3	900-800 BC	25	0.596	0.542
Ban Non Wat	Bronze Age 4	800-700 BC	87	0.663	0.603
Ban Non Wat	Bronze Age 5	700-420 BC	25	0.383	0.350
Nong Nor	Bronze Age	700-420 BC	42	0.562	0.510
Non Nok Tha	Bronze Age	1000-500 BC	37	0.526	0.478
Ban Non Wat	Iron Age	420-100 BC	70	0.477	0.433
Noen -U-Loke	Iron Age 3	200-400 AD	13	0.612	0.557
Noen U-Loke	Iron Age 4	300-500 AD	12	0.668	0.608
Non Ban Jak	Iron Age	300-600 AD	44	0.526	0.477

Table 1. Gini coefficients for Northeast Thailand. The estimates in column (5) and (6) show, respectively, the Gini computed before and after the adjustment procedure explained in the text.

Contact and competing interest for authors
Mattia Fochesato
Dondena Centre and BIDSA, Bocconi University, Via Röntgen 1, Milan 20136, Italy
mattia.fochesato@unibocconi.it
Charles Higham
Department of Archaeology, University of Otago, Dunedin 2014, New Zealand
Charles.higham@otago.ac.nz
Amy Bogaard
Institute of Archaeology, University of Oxford, 36, Beaumont Street, Oxford OX1 2PK, UK.
amy.bogaard@arch.ox.ac.uk
Cristina Cobo Castillo
University College London, Institute of Archaeology, 31–34 Gordon Square, London WC1H 0PY, UK
criscastillo@mac.com

There are no competing interests

Data sharing plans. All data employed in this submission are available for general use and application

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Members of the Editorial Board Polly Wiessner, Melinda A. Zeder, Joyce Marcus

NAS members Kent Flannery, Henry Wright, T. Douglas Price

Suggested referees

Professor Peter Bellwood, Australian National University. Peter.Bellwood@anu.edu.au

Professor Bellwood is a leading authority on the later prehistory of Southeast Asia.

Dr Fiorella Rispoli, rispoliciarla@gmail.com

Dr Rispoli is a Senior Southeast Asian Specialist, ISMEO- International Association of Mediterranean and Oriental Studies, Rome (Italy)

Professor Timothy A. Kohler, Washington State University, tako@wsu.edu

Professor Kohler is a leading authority in the study of prehistorical social inequality

Professor Branko Milanovic, Stone Center CUNY , bmilanovic@gc.cuny.edu

Professor Branko Milanovic is a leading scholar of global economic inequality.

Captions for supplementary figures

Fig. SI1

Map showing the sites and key locations. 1. Ban Non Wat, Noen U-Loke and Ban Lum Khao, 2. Non Nok Tha, 3. Khok Phanom Di, 4. Nong Nor, 5. Ban Kao, 6. Khok Charoen, 7. The Phetchabun Range, 8. Vilabouly, 9. The Khao Wong Prachan Valley, 10. Muang Sema.

Fig. SI 2. The cemetery plans for the sites analysed.

Fig. SI 3.

Upper: The average number of shell disc beads in each adult burial from the sequence at Ban Non Wat. Lower: The average number of exotic trochus shell bangles and pottery vessels in each adult burial at Ban Non Wat