AEGEAN ARCHAEOLOGY

VOLUME 4
1997 – 2000

Studies and Monographs in Mediterranean Archaeology and Civilization
ser. II volume 5

ART AND ARCHAEOLOGY
WARSAW
Case Studies of Settlement Change in Early Iron Age Crete (c. 1200 – 700 BC): Economic Models of Cause and Effect Reassessed

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Introduction

The aim of this paper is to further relate the defensible settlement phenomenon of Early Iron Age (EIA) Crete to its socioeconomic context. This still requires to be done on a number of levels, including that of Crete’s participation in Aegean/east Mediterranean exchange systems, which promoted significant economic and social change in the island over the course of the EIA. However, in this paper I focus mainly on the implications of settlement relocation for subsistence frameworks and practices in the 12th and 11th centuries. In doing so I address the question of the motivation for the shift itself, which has been raised in the literature ever since the phenomenon began to be studied in detail in the 1980s. Subsistence clearly cannot be examined in isolation from its broader socioeconomic framework, and this is analysed using various kinds of archaeological evidence. While the physical

* Acknowledgements: The research presented here was made possible by major support grants from the A.G. Leventis Foundation and the Alexander S. Onassis Public Benefit Foundation. The University of Edinburgh provided four small fieldwork grants, and the British School at Athens another. I would like to thank Donald Haggis and James Whitley for taking time to review earlier drafts of this paper in detail, and for encouraging its publication.

1 See Figure 1, showing the distribution of defensible sites of 12th to 11th-century date. The settlement pattern has specific characteristics in different phases of the EIA (c. 12th to 7th centuries BC), and constitutes not just a sensitive chronological indicator but an active cultural force in sociopolitical change, as I shall discuss. See B. HAYDEN, Fortifications of postpalatial and Early Iron Age Crete, Archäologischer Anzeiger Heft 1 (1988), 1–21; K. NOWICKI, Fortifications in Dark Age Crete, in S. VAN MAELE and J. M. FOSSEY (eds), Fortificationes Antiquae (Amsterdam 1992), 53–76; IDEM, A Dark Age refuge centre near Pefki, east Crete. BSA 89 (1994), 235–68; IDEM, Defensible sites in Crete, c. 1200 – 800 BC (LM IIIIB/C through Early Geometric), (Aegaeum 21, Liège 2000); IDEM, Sea raiders and refugees: problems of defensible sites in Crete c. 1200 BC, in V. KARAGEORGHIS and C. MORRIS (eds), Defensive settlements of the Aegean and Eastern Mediterranean (Nicosia 2001), 23–39; D. HAGGIS, Intensive survey, traditional settlement patterns, and Dark Age Crete: the case of Early Iron Age Kavousi, JMA 62/2 (1993), 131–74; IDEM, The Kavousi-Thripti Survey: an analysis of settlement patterns in the area of Eastern Crete in the Bronze Age and Early Iron Age (PhD dissertation, University of Minnesota 1992); IDEM, The Kavousi-Thripti Survey (unpublished manuscript); IDEM, A Dark Age settlement system in East Crete and a reassessment of the definition of refuge settlements, in KARAGEORGHIS and MORRIS (eds), 41 – 59; L.V. WATROUS, The isthmus of Ierapetra in east Crete and the Dark Age ‘refuge settlement’ of Profitis Elias: diaspora or local population change?, in KARAGEORGHIS and MORRIS (eds), 41 – 57.


3 HAGGIS 1993 (n. 1); W. COULSON, discussion in E. HALLAGER and B.P. HALLAGER (eds), Late Minoan III pottery chronology and terminology: acts of a meeting held at the Danish Institute at Athens, August 12 – 14, 1994, Monographs of the Danish Institute at Athens 4 (Athens 1997), 397; L. DAY, The Late Minoan IIIC Period at Vronta, Kavousi, in J. DRIESSEN and A. FARNOUX (eds), La Crête mycénienne. Actes de la table ronde internationale organisé par l’Ecole française d’Athènes (BCH Supplement 30, Paris 1997), 404.
Fig. 1. Map of Crete showing known LM III C sites.

All sites listed without brackets have use dating to the LM III C/SM period. In the legend, brackets enclose the names of sites with use apparently starting after LM III/SM. Square brackets enclose the names of sites with use for cult in LM III C/SM, but apparently without associated settlement.

Very small sites known from intensive survey – e.g. farmhouses, hamlets – are not marked, since published data on these is so uneven, and because the scale used here does not allow their locations to be accurately shown.
parameters of subsistence changed little from the preceding LM III B period, it appears that the scale and character of practices must have done. In investigating the nature and extent of change, my approach was to study the long-term interplay of wider economic and sociopolitical conditions, subsistence practices and settlement in the vicinities of selected LM III C sites, effectively highlighting the main characteristics of their likely hinterlands. I made use of ethnographic, archaeological, soils and vegetation data recovered in the field, and of published historical and ethnographic sources referring to the areas in question. I tried to build on Haggis’s use of analogy to illuminate the EIA settlement patterns of one small region in east Crete.

4 HAGGIS 1993 (n. 1).
Crete, by enlarging the scope of analysis beyond that of a single-region study and making rather more rigorous use of historical comparisons. The wider scope better illustrates both the complexity/variation in EIA settlement patterning across the island and some of its unifying characteristics, providing a stronger base for generalisation and indicating some anomalous elements in the case studied by Haggis.

The sites/site clusters selected for discussion here have contrasting individual characteristics and various types of hinterland, but they are all representative of LM IIIC patterns. I was interested in demonstrating that despite these contrasts, broad-based subsistence would be possible in the immediate hinterland of all the settlements, and that the carrying capacity of this hinterland, while varying in each case, would generally be high enough to support the estimated populations of the sites during the 12th to 11th centuries (some sites continued later in the EIA). The fact that different spans of occupation, as well as broadly different regional environments, apply within the set of examples, allowed interesting questions about the role of subsistence concerns in the longevity and the developmental character of EIA sites to be addressed. The nature and distribution of EIA settlements in the broader region of each site/site cluster were also considered, with a view to identifying any patterns of functional hierarchy as well as of settlement change over the course of the period, and assessing the relationship of both to the subsistence potential of the landscape. It was not assumed that the regional political units which have been tentatively identified for LM III A–B Crete had meaning in LM III C. As I shall discuss later, the profound degree of social and political disruption which must have accompanied the settlement shift suggests these were unlikely to have retained their force: LM III C site patterning does not show regular, predictable spatial relationships to previous regional centres, with both size and location apparently determined by a very different set of priorities. Thus several of my study areas are in the same (western Mirabello) region, but seem to represent some anomalous elements in the case studied by Haggis.

The sites are currently in a barren-looking grazed zone and at some of the highest altitudes known for EIA settlement (c. 800 m and c. 1100 m above sea level (asl) respectively). The site at Vrachasi Anavlochos, which continued and substantially expanded between the Protogeometric and Archaic periods (10th to 6th centuries BC), was chosen primarily for its longevity. Contrasting it with the Kritsa and Tapes sites – in the same region, but both abandoned by PG – allowed eco-nomic and other reasons for settlement longevity to be explored in detail.

Attention to the meaning and context of LM III C settlement systems has so far been mainly focused on eastern Crete and Lasithi, where the retrieval of settlement information has been greatest. But recent excavation and survey are throwing more light on western Crete, revealing great similarities in settlement pattern to the rest of the island, as well as some specific regional characteristics. A site cluster near Frati, in the Rethymnon isthmus, was selected for discussion because its topography – close to an extensive area of good arable land and excellent year-round water sources – as well as its illustration of the cluster pattern in this part of Crete (affording, as with the Tapes example, an opportunity to discuss the economic implications of cluster-

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ing), and the fact that a recent intensive survey covered some of the surrounding area, producing a good base of data for discussion of long-term settlement patterns. Lastly, I examine a case from central Crete, where a large number of sizeable and rapidly-expanding, very long-lived sites appear in LM III C, often with rather less defensible characteristics than are typical of sites in other regions. The landscape of this area has been exploited intensively historically and is of extremely high productive value: I wanted to examine the implications of this type of hinterland for the continuity and expansion of LM III C settlement into the PG–A period. Profitis Elias Rokka and Korifi, two large and long-lived central Cretan sites forming a cluster, provided a good example.

Methodology of the case studies

The approach used incorporates land potential assessment as well as the study of long-term settlement pattern. Delimiting actually-exploited EIA site hinterlands was of course impossible, and an artificial limit had to be adopted for purposes of consistent comparison between studies. I chose one hour’s range in all directions as likely to include at least part of any site’s/site cluster’s regularly-used hinterland, and often probably a sizeable part, unless the land within it was of extremely low quality. Ethnography in the southern Aegean shows that land well outside this small range has regularly been used for agriculture, as well as herding, and that of field houses, seasonal residences and shepherding complexes have often extended the land-use range even further. Thus in no case do I assume that the 1-hour range represented the only exploited hinterland of a site, or determined its subsistence regime. However, as Figures 2–4 show, the density of LM IIIC settlement in some areas was such that the 1-hour ranges of many sites overlapped, suggesting a fairly closely-bounded use of the landscape by each community (although use may also have taken place of more extensive areas away from the concentrations of settlement).

We cannot directly reconstruct the EIA environment, but since the general characteristics of geomorphology, climate and exploited species are known for the period, I argue that by using a variety of types of field data, supported by reference to later historical and ethnographic sources, it is possible to broadly assess the potential productivity of specific land areas at this time. Recent useful soil studies around EIA sites and other geomorphological studies from Crete indicate that a (sometimes sizeable) degree of deposition on valley floors has occurred at various periods since the EIA. Thus the hillslopes which characterise much of many LM III C site hinterlands are likely to have had more soil on them, and the plains and valley floors rather less, than is the case today. My assessments, based on present soil cover and characteristics, put all even possibly cultivable land into the ‘probable 2nd-class arable’ category for the EIA (see below), thus leaving a good margin of error. I undertook quantification of the main available soil nutrients at the present day in the full awareness that climatic variations, and changes in soil depth and structure, over time mean they would have been different in the EIA. However, the analyses do provide a indication of most soil types’ maximal potential

8 Identified by Haggis as characterising the EIA settlement pattern in his study region and clearly reflected elsewhere in the island at this time. See HAGGIS 1993 (n. 1), 140.

9 I have also undertaken the study of a long-lived coastal defensible site at Liopeitra in the far east of Crete, which I chose not to include here for reasons of space.

10 Bintliff’s work is still the main example of the application of this kind of technique in the Aegean. See J. BINTLIFF, Natural environment and human settlement in prehistoric Greece, based on original fieldwork. Parts i–ii (BAR Supplementary Series 28, Oxford 1977), particularly 605–67; IDEM, Pedology and land use, in D. BLACKMAN and K. BRANIGAN, Survey of the lower catchment of the Ayiofarango Valley, BSA 72 (1977), 24–30. Like the site catchment analysis of the Higgs school, the approach can be too environmentally deterministic when used as an explanatory mode. But in conjunction with a good range of archaeological evidence about broader socio-political and economic frameworks at any period, it provides a very valuable and badly-needed objective base on which to reconstruct ancient subsistence practice.


12 See explanatory notes at the end of this paper.

13 M.W. MORRIS, A pedological investigation of catchment basins below Late Minoan period archaeological sites in eastern Crete, Greece (PhD dissertation, University of Tennessee 1994); M.W. MORRIS, J.T. AMMONS, M.E. TIMPSON, and J. E. FOSS, Appendix 1: Soils, in HAGGIS unpublished manuscript (n. 1).

14 BINTLIFF (n. 10); N. ROBERTS, The location and environment of Knossos, BSA 74 (1981), 231–41; K. POPE, Geology and soils, in WATROUS et al. (n. 11), 197–205.

15 See the explanatory notes below for details of the analytical techniques used.
nutritive value at any period; since most Cretan soils on hillslopes relate very directly to bedrock, their basic structure and chemical characteristics today are at least partly reflective of those in the EIA. The chemical analyses actually proved most valuable in pointing up the much more important, physical factors shown by historical land-use patterns to have favoured the use of particular soils for agriculture in Crete: depth, workability (lack of stoniness), water-holding ability, and gradient.

Present land-use is often a very misleading guide to past practices, even those of 20–30 years ago, since great changes in agriculture have occurred in Crete during the intervening period. However, close study of existing vegetation communities together with cultural features (see below), and in conjunction with historical research,

16 See the studies by Morris (n. 13), which quantify this characteristic and discuss its importance to cultivation.
17 O. RACKHAM, Land-use and the native vegetation of Greece, in M. BELL and S. LIMBREY, Archaeological aspects of woodland...
can throw light on changes in land-use during at least the last 500 years. The pictures built up in this way helped to identify dominant patterns of land preference over time, and to assess land potential, in each studied region. The recording of cultural features was undertaken on a consistent basis throughout each site’s one-hour range. Though full archaeological survey was not the aim of the fieldwork, where surface ceramic material indicated the past use of an area at any period, this was noted, the type of use – e.g. settlement – suggested, and the pottery roughly dated. In some areas, previous intensive survey or more limited field studies usefully filled out the wider regional picture. Equally important to my studies were (often relatively recent) cultural features relating to past land use. These included alonia (threshing floors), terraces, boundary walls, wells, cisterns, cultivation or shepherding enclosures (the latter referred to as mandres), shepherding bases in a complex including animal enclosures (mandres with mitata), seasonal residences or groups of residences connected with agriculture (metochia), small fieldhouses for storage, and others. Mapped consistently together with vegetation and soils, and examined with regard to historical accounts of past land use, the distribution of these illustrated vividly the changes of use land had undergone in the past 30–500 years. Few land-use features could be certainly dated earlier than this, and none to the EIA itself.

**Findings of the field studies**

The studies produced a large amount of information, all generally valuable as a detailed record of past land use and settlement in Crete. Here I want to highlight the findings most relevant to issues around EIA subsistence. The data collected is all unpublished, and a fairly full and systematic exposition of it seems required to support the points I want to make. For example, I go into detail about present and historical land cover to support my gradings of arable land types, on which I then base carrying capacity calculations. Conclusions are drawn together and analysed in the next sections of the paper. The complexity of the approach used necessitates a rather large number of supporting notes, appended below.

**The case studies**

**Frati Kefala and Kefali (Figures 1, 2, 5, 6)**

These sites are located at the southern extremity of the large and fertile Ayios Vasilios valley, in the Re-thymnon isthmus of west Crete. Kefala has some traces of occupation into PG–A, and Kefali too may extend into PG, but the main period of occupation at both sites is LM III C–SM. Kefali is more intrinsically defensible than Kefala, with sheer cliffs to W and E, but neither site is fully naturally protected. The large perennial rivers and large areas of flatish arable land in the area have made it well-favoured for settlement in most periods; the relative dispersal of the historical villages may relate to the somewhat dissected character of the landscape. In nearly all periods, settlement was focused on the valley floors or low hills, although FN/EM material was found at Atsipades Korakies and on the summit of the ridge at Fonises, perhaps indicating a concern with defence at this time. There are several small MM settlements close to the valley floor: in contrast, the rocky knoll NW of the main peak of Kefala has been


20 See MOODY et al. (n. 19).
noted as a small MM II defensible site.\textsuperscript{21} In LM III A–B, there were small to medium-sized settle- ments on low hills at Spili Kefala and Koxare Ayios Markos.\textsuperscript{22} There is now also evidence for a sizeable (20–30 000 sq m) LM III A–B settlement, again on a low hill, at Koxare Aloni,\textsuperscript{23} with contemporary hamlets or houses also noted by the survey around the valley floor. At the beginning of LM III C, we see the movement to defensible sites on higher, less accessible hills at Frati Kefala and Kefali, Atsipades Fonises and Spili Vorisi.\textsuperscript{24} Smaller, dispersed settlement in the valley floors and low hills in the region accompanies this defensible site pattern, and perhaps relates to agriculture. Examples include LM III C material at Koxare Ambelos, and sites at Angouseliana and near Nea Atsipades.\textsuperscript{25} In PG–C, no sizeable nucleated settlement (typical for the period elsewhere in Crete) is known from the region. Koxare Ambelos and Koxare Koule may have been occupied continuously through the EIA and into Classical-Hel- lenistic, but otherwise Pandanassa Veni and Thronos Kefala seem to have been the nearest sites of this type.\textsuperscript{26} By Roman times settlements seem located once more on low-lying land, and dispersed.\textsuperscript{27}

An extensive scatter of Byzantine-Venetian pottery covers the lower valley floor N of Ayia Pelagia, and another scatter of V–T date found on the Frati platform seems to be associated with the remains of a chapel once used by Frati. Venetian-Turkish forts were located on Frati Kefali’s summit, on the low hill S of Koxare Koule, and on the top of the ‘Koulé’ ridge immediately S of Ayia Pelagia. Those on Kefala and Koulé were watchpoints only, while the Koxare example is a large frurio or garrison. All the present villages except Ayia Pelagia were established by Byzantine times. Thus the area was fairly densely populated by the Venetian pe- riod, with settlement mainly focused on the lower hills and valley floor. Population never seems to have risen above 500 for the four villages, suggesting at least this average carrying capacity for the area.\textsuperscript{28}

The area shows considerable diversity of land-use, both historically and in the present day, probably arising from the combination of good resources and dissected landscape already noted. The higher slopes of Kefala and Kefali (above c. 400 m asl) and the lower ridge ad- joining Kefala to its east (here referred to as the ‘Koulé’ ridge) are covered by a low grazed garigue, and on rockier parts, a maquis of oak/spiny broom. The lower slopes north of Kefala, running down to the floor of the Ayios Vasiliou valley (Papoures) are currently used for irrigated olive, vine and vegetable cropping. Most of the olive plantations here are of fairly recent date (i.e. within the last 50 years). Older olives (100–200 years+), often associated with stone-built ‘pocket’ ter- races, are found E and S of Kefala, particularly on the river banks and around Frati village. More are found immediately N of Ayia Pelagia, on the Ayios Vasiliou valley floor. On the low hills at the head of the Kourtaliotiko gorge, too, older olives (up to 200 years old, with some probably older) dominate. Further to the SE, on the ‘platform’ around Frati, there is a fair expanse of land currently or recently used for cereals. There is clear modern favouring of certain land types for particular activities. Grazed areas are mostly located on the thinner and rockier soils and steeper gradients, while olive and other cultivation is on lower-lying and more gently- sloping land, on soils with greater depth and fewer stony inclusions. But relict terracing, now covered by grazed garigue, is extensive on the rockier, thinner soils, show- ing a substantial change of use over time. Terraces cover the N, S and W lower slopes of Kefala up to a height of about 400 m, and both the N and S slopes of the Ayia Pelagia ridge. As recently as 20–30 years ago these were cultivated in cereals. The N-facing slopes of the Ayia Pelagia ridge and of Frati Kefala were also referred to by locals as having been dominated by cereal cultivation in the past, although vine and olive now play the most important role.\textsuperscript{29} Many areas of the Ayios Vasiliou valley floor now planted with young olives were said


\textsuperscript{22} S. HOOD and P.M. WARREN, Ancient sites in the province of Agios Vasiliou, Crete, BSA 61 (1966), 174, 177.

\textsuperscript{23} MOODY pers. comm.; MOODY et al. forthcoming (n. 19).

\textsuperscript{24} NOWICKI 2000 (n. 1), 200–6.

\textsuperscript{25} MOODY pers comm; MOODY et al. forthcoming (n. 19).


\textsuperscript{27} Hood and Warren recorded a Roman farmstead W of Ayia Pelagia, noted by Sanders as a probable villa. Koxare Ambelos and nearby Ayios Markos have Roman occupation, in the former case continuing from Classical-Hellenistic. See HOOD and WARREN (n. 21), 180; G. SANDERS, Roman Crete (Warminster 1982), 164; MOODY pers. comm.

\textsuperscript{28} S. SPANAKIS, Poleis kai choria tis Kritis (Iraklion 1991), 48, 422, 542, 803.
previously to have supported cereals. Terrace remains, and a concentration of alonia, around the vil-
lage of Ayia Pelagia tell the same story. Previously more-extensive cereal cultivation was referred to around Frati village (where alonia are also found). There are still substantial areas under cereals in the E part of the Frati platform and on the lower S slopes of Kefala’s SW hill. An aloni in a small area of cereal cultivation about halfway up the E slope of Kefali, noticeably isolated from the surrounding garigue and associated with the remains of an old farmhouse and animal enclosure, shows the historical use of this area for cultivation alongside grazing, though the latter has taken over today. The same indication is given by a complex of fieldhouses, terraces and boundary walls on the lower N slopes of Kefali. There were formerly several water- mill mechanisms at Mixorrouma (in use until the 1960s), processing both cereals and olives showing the im- portance of both crops in the region. Boundary walls/ cultivation enclosures are common in the area and relate to the historically mixed, intensive use of land. Because agriculture has retreated, they are now often located wholly within grazed zones. Long boundary walls appear on the N-facing slopes of Kefala’s SW hill, and on the N and S slopes of Kefali, where they usually separate areas of relict terracing from higher, steeper and rockier slopes (presumably used for grazing in the traditional system). Seasonally-used structures, relating to herding or cultivation activity at a distance from the main settlements, are rare in this region, in comparison with the others studied. This probably relates to the density of small settlements within the agricultural zone. The availability of large amounts of well-watered prime arable land in the region must partly explain the fact that large-scale grazing was never focused here, but on the steep, rocky slopes of the Kouroupas massif to the west.

Soils are mostly derived either from the weathering products of hard limestone (summit of Kefala and most of the Kefali hill) or those of the metamorphic flysch (much of the N and S slopes of Kefala). On the Ayios Vasilios valley floor and Frati platform, the mixture and sorting of both types of products, and of those of ophiolitic outcrops (particularly serpentinites) located in the Kouroupas massif to the W, has produced fine-textured, deep deposits, sometimes clayey in quality (C9, C10). Analyses of the soils showed that the lime- stone terra rossas had the highest levels of available nutrients, but the other data indicated these had never been the most intensively-used soils, probably thanks to their thin, rocky character and generally steep gradients.

Around 750–900 ha of prime arable land (more of second-quality land) would be needed to support the estimated number of inhabitants at the two LM III C sites (see Table 1). If all prime and second-class arable (including a large portion of probable second class arable) was exploited, the population of both EIA sites could practically have been supported from the 1-hour territory, but this degree of intensive use is unlikely. Exploitation beyond the 1-hour limit almost certainly took place, perhaps onto the fertile floor of the Ayios Vasilios valley, or the Lefkoyia plain at the S end of the Kourtaliotiko gorge. The EIA settlements are likely to have had a large overlap in the territory they exploited, particularly in the area of the Frati platform. The river resources, like the arable, must have been used by both sites. Although the hinterland exploitable from the prehistoric, historical/traditional and EIA settlements is very similar, the main EIA settlement locations are clearly less convenient, both with regard to arable land and to the main water sources, than those of any other period. However, they have other advantages, especially defensibility (the Venetian-Turkish watch-point on Kefali indicates the enduring value of the location for this purpose). Both have very good strategic views, particularly when working together, since each blocks the other’s perspective in one di-
rection.

**Vrachasi Anavlochos (Figures 1, 3, 7, 8)**

The Anavlochos ridge (500 – 600 m asl) lies directly N of the village of Vrachasi on the N side of the Nea- polis–Selinari ‘corridor’, a broad valley running NE – SW, linking the western Mirabello Bay area with the north coast of Crete. It is difficult to scale at many points on the S, except at the saddle where the site itself is located, and at a point just behind the village of Vrachasi. Even these routes involve steep ascents, near-vertically over rocks in some places. Also defensible are the NE slopes – very steep and rocky, with cliffs in parts. However, at various other points on the N, the ridge can be climbed within

29 Also indicated by alonia on the lower N-facing slopes of Frati Kefala’s SW hill.

30 The initial fieldwork was later extended to cover the region S and W of Kefali, to provide a wider characterisation of the hinterland of the settlement there. The results of this additional work will be published in a future paper.
about half an hour. Its size is too large to make it fully defensible, but it is a strategic viewpoint, looking N to the wide approaches from the coast and S over the valley route. The wider area is rich in settlement of the EIA. Dreros, Milatos, and Anavlochos itself have occupation from LM III through Archaic, all apparently without breaks in occupation. LM III sites not occupied after PG include Neapoli Kastri, opposite Anavlochos across the valley to the S, and a number of sites in the northern foothills of the Lasithi mountains, SW of Neapoli. Identification can be clearly made of LM III occupation.

Historically, a major transit route also ran across the low hills to the north of the ridge (E. PLATAKIS, Palaiies ekklisies sto Vrachasi, Amaltheia Tomos F', Tevkos 11 (1971), 97; E. KARAVALAKIS, Ena dysegreto keimeno tou 1834, me plirofories yia tin periochi tis anatolikis Kritis, Amaltheia Tomos I', Tevkos 70/71 (1987), 5–6.

material on Anavlochos (particularly concentrated on the western, higher, and more craggy summit)\(^\text{34}\) but the settlement clearly expanded considerably over the PG – A period. The remains of a large (not clearly datable) perimeter (?) wall are visible in the N part of the saddle.\(^\text{35}\)

The upper part of the ridge is of hard Jurassic limestone, which produces thin, rocky terra rossa soils. Lower on its slopes a layer of soft limestone produces deeper soils, high in chemical fertility and incorporating some nutrient-rich weathering products of the hard limestone. On the S, below about 360 m asl, phyllite dominates

\(^{33}\) These sites are discussed in the Tapes case study, below.


\(^{35}\) Hayden (n. 1), 16 – 17; Farnoux and Driessen (n. 34).
Fig. 5. Contour map of Frati area, showing EIA sites. Contour interval 20 m
the whole valley and produces deep, easily-worked soils. The latter two soils have historically been consistently favoured for agriculture (see below). On the low hills to the N, a mixture of soil types, derived from various outcrops of hard limestone, phyllites and quartzites, mixed with deposits eroded from the main ridge, is seen. A large spring is found at the limestone/phyllite boundary on the S slopes, where the village of Vrachasi is located.

Intensive archaeological survey has never been undertaken in this area, so that much of the prehistoric settlement pattern remains unknown. My fieldwork recorded a lower-lying site up to c. 8500 sq m immediately N of Anavlochos, dated from LM III C onwards, and one, datable somewhere in PG–A, located S of the ridge (Fig. 7). Both are about 20 minutes’ walk from the summit and suggest agriculturally-related satellite settlements on deeper, more easily worked soils than those around the main site. A settlement at Vrachasi is documented from at least 1391, when it was already fairly large (population 475 by 1577). Both it and neighbouring Latsida (on the valley floor to its SE) flourished as large villages (above 600 people) into the 20th century, but the abandonment of many smaller settlements has been occurring over the last 200 years in favour of the nucleations at Malia and Sissi on the north coast.

The present boundary between cultivation and pasture on Anavlochos follows a similar contour all round the ridge. Few olives reach onto the steep terra rossas. The E slopes above c 350 m asl and the N ones above c. 330 m are entirely covered by grazed garigue or medium-height maquis. On the S, the higher part of the cultivated area (up to 360 m asl) is completely dominated by young olives (under 50 years old). Lower down to the S and E (on the valley bottom and lower E slopes) are the oldest olives, up to c. 150 years old and unirrigated. There is a very limited extent of olives over c. 15 – 30 years old on the terra rossas on the N side of the ridge, the latest area of olive expansion. Carob was also an important crop here in the past. Large areas of excultivated carob/olive maquis, with trees of about 80 – 100+ years old, are located on the lower E and SE slopes of the ridge. These old plantations are on the margin of the rocky and thin terra rossas, contrasting with the areas of old-established olive cultivation. Almond and carob are frequently mentioned in records concerning the region in the 16th and 17th centuries, which also show that barley/wheat and pulses were grown in substantial quantities – a substantial contrast with today’s complete dominance of olive. Vines were also grown, although they were never very important. In the 1830s, there was still a substantial mixture of cultivated trees – almond, plum and carob – with olive in the Latsida area. Regular exports of local olive oil and carobs grown in the region took place from Milatos and Sissi in the early 19th century.

The large nucleations at Vrachasi and Latsida exploited the surrounding lands through a fieldhouse system from at least the Turkish period. The remains of farmhouse or metochi groups and single units are numerous, particularly along the N base of the ridge. The historical emphasis on olive, carob and nut production involved intensive seasonal labour, but these bases were also concerned with cereal cultivation, as a nearby complex of windmills shows. Topographically, the bulk of Anavlochos blocks easy access between Vrachasi and the lands to its N, explaining the concentration of farmhouses here. Some are still in use today. However, the exact nature of their use has changed in the last 50 – 70 years, from being lived in for a significant part of the year and associated with mixed cultivation, to completely non-residential use (during the period of the olive harvest only).

36 A possible MM peak sanctuary has been identified on the summit of Vigla, at the eastern end of the Anavlochos ridge (K. NO-WICKLI, Some remarks on the pre- and protopalatial peak sanctuaries in Crete, Aegean Archaeology 1 (1994), 48).

37 Demargne noted the presence of PG–G sherds at the bottom of the ridge on the N and E, including cult material at Kako Plai, very close to this scatter. Whatever the character of the site, it must have been closely linked to the main settlement above (J. DEMARGNE, Recherches sur le site de l’Anavlochos, BCH 55 (1931), 368–9, 379–407).

38 SPANAKIS (n. 28), 202–3.

39 PLATAKIS (n. 31), 100–1.


41 E. KARAVALAKIS (n. 31), 5–6.

42 In 1842 the main products of the region are listed as including oil, almonds, carob and dairy products. (Ch. BYZANTINOU, Kritika syntachthenta kai ekdothenta (Athens 1842), 48. All the first three were still being exported from nearby Sissi in the early 20th century. NOUCHAKI (n. 40), 103; SPANAKIS (n. 27), 715.
Fig. 6. Arable zoning map of Frati area
On the higher slopes of Anavlochos, the now garigue-covered terraces mostly seem to have been used for cereals in the past. The terraced areas abandoned to grazing and not re-used for agriculture are usually those on limestone terra rossas, while ex-grain terraces on the lower phyllite soils have often been planted with olives in the last 50 years. Past grazing of the higher slopes of the ridge is testified to by a few stone-built enclosures or small pens, sometimes on their own, sometimes forming part of a *mandra/mitato* complex, indicating mixed smallholding practices. Current grazing on Anavlochos is specialised and extensive: the ridge is used as a grazing ‘block’ by a large herding operation based elsewhere.

It was found, as in other areas, that while the hard limestone soils were high in nutrients, they had been historically disfavoured for intensive agriculture. Today these inaccessible zones are not considered worthy of any kind of cultivation, in the context of a decline in cereal agriculture and an emphasis on cash crops. But they do represent a significant area of second-quality arable land in the immediate hinterland of the EIA site. The carrying capacity of the 1-hour range was sizeable, and would seem well able to have supported the estimated LM III C and later population (see Table 1). As the settlement expanded between PG and A, problems may have arisen from the concomitant territorial expansion of Milatos and Dreros; on the other hand, the abandonment of Neapoli Kastri by PG means its hinterland is likely to have been available for use by Anavlochos from that time onwards.

The EIA and traditional settlement locations are significantly different here, although they have nearly the same hinterland. The large historical village was sited on the highest point, on the spring line and at the junction of the deepest, most easily worked soils on the valley floor with the stony terra rossas on the steeper slopes above, allowing reasonable access to the higher slopes of the ridge for grazing or cultivation (as evidenced in the past), but also, more importantly, to the largest prime arable areas. In contrast, the main EIA settlement location is wholly surrounded by the lower-quality land (which would require a substantial investment in terracing to cultivate), and had more difficulty in accessing the lower-lying prime arable areas. However, it benefited from a strategic viewpoint over a very large surrounding area. The productive nature of its sizeable 1-hour hinterland supports Haggis’s reconstruction of agriculturally-based, self-sufficient strategies for EIA settlements, but there is no obvious economic reason to use the ridge top itself, and other (defensible) considerations were clearly the most important. Significantly, in view of the continuity of occupation here through the EIA, there is substantial room for expansion on the same site. The fact that the location commands a good arable territory, with an immediate hinterland adequate to support a population much larger than that estimated for LM III – SM, may also have favoured the settlement’s longevity and expansion.

**Kritsa Kastello (Figures 1, 3, 9, 10)**

This site, first occupied in early LM III C and abandoned by PG, lies above and west of the village of Kritsa. It stands 590 m asl, a hill of hard grey limestone with sheer cliffs to north, east and south, and has good defensible characteristics, although its western side, where a saddle joins it to higher slopes behind, had to be protected with a fortification wall.44

Kastello forms part of the eastern foothills of the La-sithi range, which have scars of hard limestone on their eastern sides. The small gorges penetrating these scars hold winter watercourses draining onto the flat *kampos* (plain) below to the E. This area covers c. 5 square km, surrounded on three sides by low hills of flysch, soft limestone and phyllite. A springline is located at about 340 – 50 m asl on the E slopes below Kastello, and the site of the modern and traditional village seems to reflect the long-term importance of this. The springs are not substantial enough to have supplied historical irrigated cultivation, as the large number of small stone-lined wells of various dates on the lower eastern slopes of Kastello and Plativolo, and on the *kampos*, show. Garden cultivation has historically been important on the latter area, with its deep, mixed soils, and along with irrigated olive, is a main land user there today.

Little is known about the prehistoric settlement pattern of the area. An LM IIIA – B settlement may be

43 *The metochia* have seen changes of owner residence away from Vrachasi, but many owners still live in the wider region; e.g. Neapoli, the Potamoi valley area. *Alonia* and broad terraces associated with some structures indicate the past cultivation of cereals or pulses, not found at all in the area today. In one case, olives of up to 70 years old surrounded and partly obscured an *alon*; in another, young olive planting covered the whole areas of a sizeable farmhouse complex with terraces and boundary walls.


45 J.P. de TOURNEFORT, *A Voyage into the Levant*, perform’d by command of the late French King (London 1718), 36; T.A.B. SPRATT, *Travels and Researches in Crete* (London 1865), 110, 137. The soils probably have high water-retaining qualities (by analogy with the findings of Morris; MORRIS et al. (n 13).
expected on or near the Kritsa kampos, since tholos tombs of this date were found on a low hill there, and also near the present village to the W. The nearest contemporary settlement appears to be at Lato (3.5 km to the NE), where excavated occupation layers go from Geometric through Hellenistic, but where there is, according to Nowicki, surface pottery dating as early as LM IIIC–PG. From PG onwards, Lato seems to have drawn up population from the whole surrounding area, including the Kastello settlement and those at Tapes (see below). Evidence for Roman settlement is scarce in the locality. Kritsa village has at least Byzantine roots and has traditionally been one of the largest villages in the Mirabello region. Population seems to have remained above 1000 since at least the 16th century, and above 2000 through the 20th century. The large size of the historical population

46 N. PLATON, I archaeologiki kinisis en Kriti kata to etos 1951. KCh 5 (1951), 444; KANTA (n. 32), 134–39; M. TSIPOPOULO pers comm.; M. TSIPOPOULO and L. VAGNETTI, I isterominoikon

must be linked to the attractive arable qualities of the kampos, but the modern village is supported by a variety of means, including specialised herding and a crucial element of tourism.

The immediate area has a large proportion of deep, easily workable soils, derived from mixed products of soft limestone, fyllych and phyllite around the lower hillslopes and on the kampos. But on the higher slopes around Kastello and Plativolo, thinner, rockier limestone terra rossas predominate. Tree crops have long been important here, and large stands of excultivated almonds are seen, which date in the last 1–200 years – such as the semiwild maquis covering the summit and slopes of Kastello. Old olives and carobs cover parts of the lower terra rossa slopes around the village. The present large areas of garigue-covered terra rossa – e.g. on Plativolo and the higher slopes to the W – often have signs of past cultivation in cereals and/or legumes. Broad terraces associated with building complexes reflect the combined practice of herding and cultivation on a small-holding basis here in the past 100 years, showing the versatility of these barren-looking areas, whose soils have a high available nutrient content. On the kampos and lower hillslopes there is plenty of evidence for past diverse, but concentrated, agricultural use: numerous alonia and terraces (where gradient required these), and old boundary features such as lines of very old olives. Although garden crops and olives were important here in the past, the complete disappearance of cereal cultivation from the kampos in their favour has occurred only in the last 50 years.

Soil analyses, in conjunction with the field studies, showed that as at Anavlochos and Tapes (see below), a ‘combination’ soil type, over soft limestone bedrock but incorporating a small element of hard limestone weathering products is one of the most chemically fertile, and also possesses good workable qualities. However, it is limited in its extent, which is unlikely to have been much larger in the EIA. More extensive, historically and presently most-favoured, and also high in fertility, are the kampos soils, with the adjacent mixed phyllite-/fyllych-derived soils. As in the other areas studied, the whole emphasis of settlement and cultivation in most periods appears to have been on the lower-lying areas. The LM III C settlement’s position is remarkable from this point of view. Although access to the best arable areas can actually be achieved from it fairly quickly (by precipitous descent at one place only down the E cliffs, or a by longer walk around from the W), accessibility is made significantly more difficult by the location, which seems to have been mainly chosen for defence. At the same time, the proximity of a good defensible location to such a valuable arable area was probably the reason for the location of such a large site here.

The subsistence needs of the Kastello population could even have been met within the 1-hour range, with a very intensive use of land, but it seems reasonable to suggest that use was made of areas outside this – perhaps the further eastern extent of the kampos, or the higher second-class arable/uncultivable rocky slopes to the W. If the latter, extensive terracing would be needed for cultivation, or they might have been used for herding. The presence of a settlement at Lato may always have constrained use of the high-quality arable to the N and E of the 1-hour range. The desertion of Kastello from PG may seem difficult to explain, given the room for expansion on the site and its large arable catchment. However, Lato, while having both these characteristics, also had better topographical accessibility and a better view of the seaward approaches to the E and large Lakkonia valley to the N – i.e. the ability to dominate a larger political and economic territory.

Tapes Epano and Kato Kastello (Figures 1, 3, 11, 12)

There are relatively few LM III C settlements at these altitudes (1110 m and 780 m asl respectively). Besides this height factor, there are several others which make the Tapes sites fit some of the popular (but as I shall argue, somewhat misleading) perceptions of LM III C sites: they are located in an area on the current margins of agriculture and now strongly orientated to herding, with a high proportion of steeply-sloping, rocky land in their hinterland. They are also remote from known LBA settlement centres.

Epano and Kato Kastello are rocky knolls atop a high ridge of hard limestone. This slopes steeply down on the north to the Potamoi valley, a natural route leading westward into the Lasithi mountains from the Neapoli area. To the S of the Kastellos lies the narrow NW- to SE-running valley where the village of Tapes is located (c. 530–560 m asl). The Potamoi valley has several LM III C sites along its course (Adrianos Fortetsa, Drasi

BCH 95 (1971), 167–222; NOWICKI 2000 (n. 1), 119–20. 48 Although see SANDERS (n. 26), 141.
Although defensible, these do not occupy good vantage points, being hidden in the depths of the valley. The Tapes sites have different topographical characteristics.

They are intrinsically highly defensible, by virtue of steep slopes and cliffs surrounding their summits and command an excellent view over a large area of lower-lying land and the sea to the E, as well as the valleys to the N and S. Only to the W do the higher peaks of the Lasithi range block long-range visibility.

The Tapes valley contains a seasonal stream and several small springs. Low hills of hard limestone with terra rossa soils run S and E from it to the large Lakkonia valley, 5 km from Tapes. Though bounded by hard limestone hills, the Tapes valley floor has soils derived from phyllitic flysch exposed along its sides and bottom. The flysch weathering products are often overlain by

\[\text{Fig. 8. Arable zoning map of Anavlochos area}\]

\[\text{SPANAKIS (n. 27), 439.}\]
those derived from the hard limestone, forming a ‘combination’ soil type of the type seen at Anavlochos and Kritsa Kastello (see above). A large spring is located in the ‘Chalasa’ scree W of Epano Kastello, and another on the N slopes of Epano Kastello, at about 900 m asl.

Little archaeological fieldwork has been carried out in the area, and its ancient settlement pattern is practically unknown. The nearest LM III A–B settlement may be in the Lakkonia valley,\textsuperscript{53} Nowicki first properly recorded and dated the LM III C sites (and a third possible one at Charakas, a small knoll in the Tapes valley).\textsuperscript{54} All are abandoned by PG – perhaps, like Kritsa, in favour of settlement at Lato. The area’s history between PG and Late Byzantine is very little known. A settlement at Tapes appears in Venetian records.\textsuperscript{55} The population stayed small, at around 100, during most of the Venetian and Turkish periods. A related small permanent settlement, now used as a metochi, existed at Palaio Tapes (SE of the village, in an arable ‘pocket’ with a spring) from at least the late 18th century.

Despite the current dominance of grazed garigue in this area, particularly on the terrae rossa soils with steep gradients, many cultural features show the previous use of such zones for mixed cereal/legume agriculture and herding. The very steep slopes immediately N of the Kas-tellos are mostly terraced all the way down to the Potamoi valley floor, and have examples of abandoned small-holding complexes on them as high as 900 – 1000 m asl. The latter incorporate working/residence structures, animal enclosures, and alonia, with two large cisterns, shared by several of the complexes. The density of terracing here, in contrast to that seen in other, similar zones of 2nd-class arable at Kritsa and Anavlochos, demonstrates the past need (arising from a shortage of prime-quality arable) to use this poorer land with greater intensity. Property boundary walls and field enclosures in the same zone also show an historical intensity of use. All these features date within the last 200 – 300 years, but have often only gone out of use in the last 40 – 50. The valley floor, the main prime arable area, were always intensively used for cereals, legumes and vines. A previous use for tree crops of the rather rocky slopes and lower hills S of Kato Kastello is demonstrated by the character of the maquis now covering this area, which contains large amounts of semi-wild olive and carob. Thus the appearance of large tracts of the landscape which currently appear barren or wild has changed in the very recent past. Nutrient analysis in conjunction with physical characteristics explains the high desirability for agriculture of the combination-type soils in the valley, but the phyllite soils, larger in their extent, have been equally favoured, mostly thanks to their workability and low gradients.

As in the Frati area, traditional settlement was dispersed, partly because of the highly dissected landscape, but also because good arable was scarce, requiring the use of the 2nd-class land on the higher hillslopes (less necessary in the Frati case). To aid this, and because herding was also significant in the traditional economy, extensions of settlement were also used, in a way not seen in the Frati region. I will return below to the specific and more general, contextual reasons for which I think the Tapes EIA settlements were unlikely to have had a specialised herding focus, even given the agricultural constraints just described.

An issue I shall further discuss, already highlighted above, is the close bordering or overlap of many LM III C sites’ immediate hinterlands. This raises the question of whether site ‘clusters’, as defined by Haggis, can be distinguished in meaning from sites which are closely proximate, but placed slightly further apart than the 0.5 km he suggests,\textsuperscript{56} and of how such settlements interacted in the course of subsistence activity. Exploitation of the large areas of 2nd-class arable lying between the Kastellos and Adrianos Fortetsa, for example, must certainly have required some form of regular negotiation between the communities.

The arable grading and carrying capacity exercise here produces a result in line with what we might expect from studying the traditional settlement pattern and economy. Although theoretically subsistence needs could be met if almost every square metre of the 1-hour range was used, it is almost certain that the less-intensive use of a wider area, including a large proportion of second-class arable, took place. This case provides an especially dramatic example of differential preferences in the location of historical/traditional and EIA settlement. The EIA sites are very obviously not best-placed for exploitation of the sheltered prime arable in the valleys. The walk from Epano Kastello to the Tapes valley floor is 40 minutes or more. Kato Kastello, while closer, still does not command the prime arable nearly as well as does the historical/ modern village. As in the other areas discussed here, EIA settlement

\textsuperscript{50} As indicated by the fortification wall.

\textsuperscript{51} Above the current limit for olive cultivation (c. 700m asl).

\textsuperscript{52} NOWICKI 2000 (n. 1), 110–7.
priorities were driven by other factors than subsistence. The choice of the Kastellos must have related to their intrinsic and strategic defensible qualities, especially as part of a wider defensible system of settlement. The high visibility of both sites from a great distance around perhaps had a symbolic as well as a defensive value. The abandonment of both sites by PG is likely to relate at least partly to the inaccessible nature and limited size of their political and arable catchment by comparison with, for example, that of Lato.

Fig. 9. Contour map of Kritsa area, showing EIA sites. Contour interval 20 m

Profitis Elias Rokka and Korifi (Figures 1, 4, 13, 14)

The last case chosen for study exemplifies a type of large, long-lived EIA settlement to which Vrachasi Anavlochos also belongs. In this case the occupation is even longer-lasting – well into the Classical period and to Hellenistic in the case of Rokka. The site settlement takes the form of a ‘cluster’ or pair of very closely-adjacent sites (separated by less than 1 km). Both are fairly difficult of access (Rokka has very steep cliffs on its W and S sides), but seem to have derived most of their defensibility from the size of the communities.

53 Where Nowicki has found surface material of this date (NOWICKI pers comm).
55 SPANAKIS (n. 27), 755; NOUCHAKI (n. 40), 94.
based there and from their strategic location. There may also have been fortifications on Rokka’s vulnerable saddle – evidenced, but perhaps obliterated by the later (Venetian) ones. Unlike the other EIA sites studied here, Rokka shows long-term use in the historical period – but as a fort only, drawing our attention to its defensible characteristics. Another interesting feature in this case, which again points up the operation of very special settlement criteria operating in the EIA, is the presence of a large LBA settlement on the very saddle between the two EIA sites. There could not be a much more direct and vivid example of settlement movement between the two periods. A set of contrasting inferences can be drawn about subsistence practices at EIA sites like these, where relocation of LBA settlement took place within a very small vicinity, and others, where the shift covered a greater distance (see below).

The landscape of this part of central Crete is open, rolling and of generally high arable quality. Apart from the basement of hard limestone with in situ terra rossa soils, of which the two hills and the Kormos ridge to their N are formed, the combination soils on their lower slopes, and a basin of colluvium between them, the land in all directions around, (running down to the two broad valleys to E and W) is a soft pure marl which produces fine, light soils in situ. While probably poor in water retention, the chemical fertility of these soils is high, and they have been in intensive use for vine cultivation since at least Venetian times. Nonetheless, as in most other areas studied, the intensity of recent tree cropping is exceptional. Vines, and to a lesser extent, olives, now stretch as far as the eye can see, although historical sources indicate grain and some grazing in the area until as late as the early 20th century. The intensive character of historical agriculture demonstrates the fertility and physical ease of cultivation of most of the landscape; only the hills themselves are uncultivated islands in a sea of green.

The Vitsiles settlement, mentioned above, appears to start in EM and lasts into LM III B. Its size from the MM period onwards is estimated at around 18 000 sq m. My fieldwork also found large scatters of MM–LM pottery on the gentle lower slopes NE of Korifi and E of the Vitsiles site – the latter perhaps an extension of the main settlement – but is not clear if these continued all the way into LM IIIB. In the wider area there are good indications of a fairly scattered, but dense LM III A–B settlement pattern, representing a substantial population in the area, which seems to have been retained after the relocation in LM III C. After the Classical-Hellenistic period the Rokka and Korfi sites went out of use (Sanders suggests that the main Roman settlement in the area was on the site of the modern Profitis Elias village). In Late Byzantine, Rokka was fortified, and became an important military stronghold, retaining this function into the Venetian and Turkish periods. A large village grew up alongside the fort. The pattern of traditional land use was apparently based mainly on this nucleated village, which had large arable areas easily accessible from it in the open landscape, and so little need for fieldhouses or other settlement extensions.

A hamlet dating back to Venetian times, and abandoned only about 50 years ago, is located at Ayia Anna, at the NE foot of Korifi. In general, then, both prehistoric and historical ‘normal’ – i.e. not defensibly-specialised – settlement was on the low-lying, gently-sloping areas. As elsewhere, the LM III C site locations are the exception to this rule.

Soils analysis, arable grading and carrying capacity calculations indicate that within the (large) 1-hour range of the EIA sites there was a very high proportion of first class arable land. The large community could be easily supported by its use, or by the use of closely-adjoining areas. The latter, given the absence of rival settlement in the immediate region, was probably unproblematic at first, although the expansion of other central Cretan settlements’ territories must have imposed firmer boundaries in the course of the PG–A period. I have mentioned the open character of the landscape in this region. This seems deeply relevant to the Profitis of the first millennium BC from the Alps to Anatolia. Proceedings of a conference held at the University of Birmingham, January 2000 (forthcoming).
Elias sites’ location and success, since it provided not only an optimal subsistence hinterland, but access to a number of important communication routes traversing the island. From PG onwards, archaeological evidence shows that the whole of central Crete was a core of socioeconomic development, seemingly related to a high level of external contacts and to the good communications links within the area. The growth of many large sites in the region in the PG–A period must have been linked to this development, and also have helped to promote it. Given all the favourable attributes of their location – some of which were significant mainly in the changing socioeconomic context of the PG–A period – it is not surprising that the Profitis Elias sites enjoyed such longevity.

58 S. MARINATOS, Anaskafi en Lykasto kai Vathypetro Kritis, PAE (1955), 306–10. There is also LBA material on the hill of Rokka itself (L. MARIANI, Antichita cretesi, Monumenti Antichi 6 (1895), 234–5), but the main settlement area was undoubtedly on the saddle at Vitsiles.

59 J.S. PENDLEBURY, The Archaeology of Crete (London 1939), 60; MARINATOS (n. 57); E. SAPOUNA-SAKELLARAKIS, Archanes à l’époque mycénienne, BCH 114 (1990), 87–88.
Table 1.
Table of carrying capacity calculations (all sites). See explanatory notes

<table>
<thead>
<tr>
<th>Site</th>
<th>Frati Kefali and Kefali</th>
<th>Vrachassi Anavlochos</th>
<th>Kritsa Kastello</th>
<th>Tapes Epome and Kato Kastello</th>
<th>Chamairi Liopeuta</th>
<th>Profitis Eiai Rolka/Korifi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total 1-hour range</td>
<td>1100 ha</td>
<td>1300 ha</td>
<td>1263 ha</td>
<td>1518 ha</td>
<td>848 ha</td>
<td>1579 ha</td>
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<tr>
<td>Total available arable</td>
<td>620 to 785.5 ha</td>
<td>663.5 to 874 ha</td>
<td>580 to 942.2 ha</td>
<td>473.2 to 962.4 ha</td>
<td>441.4 to 588.1 ha</td>
<td>1508.4 to 1521.8 ha</td>
</tr>
<tr>
<td>No. of individuals able to be supported on 100% cereals, annual fallow</td>
<td>517 to 658</td>
<td>553 to 728</td>
<td>484 to 786</td>
<td>394 to 802</td>
<td>371 – 460</td>
<td>1252 to 1268</td>
</tr>
<tr>
<td>No. of individuals supported on 100% animals (minimum) – assuming only cleared land grazed (or all land grazed, in brackets)</td>
<td>12 to 16 (22)</td>
<td>13 to 17 (26)</td>
<td>12 to 19 (25)</td>
<td>9 to 19 (30)</td>
<td>9 to 12 (17)</td>
<td>25 to 30 (32)</td>
</tr>
<tr>
<td>Total no. of individuals able to be supported – assuming only cleared land grazed (or all land grazed, in brackets)</td>
<td>531 (539) to 674 (680)</td>
<td>566 (579) to 745 (754)</td>
<td>496 (509) to 805 (811)</td>
<td>403 (424) to 821 (832)</td>
<td>383 (383) to 502 (507)</td>
<td>1282 (1284) to 1298 (1300)</td>
</tr>
<tr>
<td>40% of total</td>
<td>212 (216) to 270 (272)</td>
<td>226 (232) to 298 (302)</td>
<td>198 (204) to 322 (324)</td>
<td>161 (170) to 328 (333)</td>
<td>175 (178) to 291 (293)</td>
<td>513 (514) to 519 (520)</td>
</tr>
<tr>
<td>Estimated site size (square metres)</td>
<td>c. 15 000 (Kefali) and c. 10 – 15 000 (Kefali)</td>
<td>c. 15 000 ?</td>
<td>c. 30 000</td>
<td>c. 22 000 (Kato Kastello) and c. 10 000 (Epome Kastello)</td>
<td>15 – 20 000</td>
<td>Not possible to estimate – minimum 15 000</td>
</tr>
<tr>
<td>Estimated population for the site or sites (minimum),</td>
<td>c. 521 – 750</td>
<td>c. 313 – 375</td>
<td>c. 625 – 750</td>
<td>c. 479 – 575</td>
<td>c. 313 – 500</td>
<td>c. 625 – 750</td>
</tr>
</tbody>
</table>

Conclusions on the relationships between EIA settlement and subsistence

It is the contrasts, rather than any analogies, between EIA and traditional/historical settlement and subsistence which I have been concerned to point out here (contra Haggis 1993). The dominant patterns of long-term settlement, land-use and land favouring in conditions of unmechanised agriculture (always influenced by larger-scale social and economic frameworks), give a good indication of land potential in each case study area, and a firm basis from which to identify these contrasts, many of which have already been pointed out in the discussion above. In all cases the EIA settlements had more difficult access to arable or water than historical, traditional, or LBA settlement. The difference in access may be rather small (as at Kritsa, Frati) or considerable (as at Tapes) but it is always seen. Thus other factors than subsistence certainly prevailed in locational choice. Nevertheless, the present-day carrying capacity of the immediate hinterland of each site was always about adequate to support the estimated EIA populations on a mixed farming basis. Given a generally greater depth of soil on hillslopes in the EIA, large parts of these hinterlands must have had an even higher potential at that period.

60 SAPOUNA-SAKELLARAKIS (n. 59), 67 – 102.
61 This dating for the inception of the main occupation at both sites is based on my own observations on Korifi and Nowicki’s for
Fig. 11. Contour map of Tapes area, showing EIA sites. Contour interval 20 m
The density of small settlement, whether within clusters or slightly more widely-spaced, often seems likely to have produced a significant overlap between subsistence hinterlands. This is true in several regions, except perhaps central Crete (where a different kind of defensible topography seems to have encouraged a different, more widely-spaced and nucleated distribution). The implication is that frameworks of subsistence activity would frequently have had to be negotiated.67 As the settlement pattern changed from PG onwards, with the expansion of some settlements and their territories and the abandonment of others, access would have to be negotiated on a larger scale (or, in fact, institutionalised). This is an interesting subject, which I address in another paper.68

The LM III C settlement change itself must have created (as well as have reflected/been caused by) the fragmentation of large-scale sociopolitical systems. Most regional political/economic centres were abandoned. Though the old centres or important sub-centres – Knossos, Phaistos, Chania, and a few others69 – continued to be occupied, it was on a different scale, with internal spatial readjustments suggesting changed forms of societal organisation. Their previously-existing support systems, both of rural dispersed and regionally-nucleated settlement70 changed so fundamentally that it would have been impossible to maintain existing kinds of organisational links within regions. Instead, new relationships (and new day-to-day physical contacts) must have emerged between new settlements all over the island,71 further helping to sever old political and economic bonds. The absence of supravening structures of political authority/security, of established markets, and (at least initially) of consolidated control by the new small communities of large territorial areas, would combine to discourage large-scale, high-investment activities such as specialised herding (evidenced neither by the settlement distribution nor by other parts of the LM III C archaeological record, see below). The same factors, as well as the broken, defensible topography of settlement (and the insecure conditions which gave rise to defensive reactions) must all have encouraged fairly small-scale self-sufficiency as a primary concern. However, forms of (kinship- or follower-based) reciprocal alliance between communities, small-scale complementary exchange of produce, or even membership of more than one community accompanying with rights to land use, by some individuals are likely to have operated, given the frequent overlapping of subsistence hinterlands. In a case like that of the Tapes sites and Adrianos Fortetsa, the contrasting but closely adjacent hinterlands of the two settlements/groupings might encourage a degree of complementarity. Nowicki has suggested something similar for Karfi – above the limit for olive cultivation – and the much smaller settlements on the lower slopes to its north.72 But while the comparatively large size and complexity of Karfi would suggest a satellite pattern around a single main settlement (which also may have been the case at Anavlochos, see above), in many other cases there is little evidence for differentiated socio-political or economic relationships within settlement clusters or regional groups. Inequalities in hinterland potential or in previously-existing levels of infrastructure might give rise to early inequalities in economic relations – e.g. between a site like Arkades (Afrati) and one like Erganos,73 or between the Tapes sites and Lato/Kritsa Kastello. But fully-specialised subsistence production systems and truly interdependent exchange relationships at settlement level are unlikely for the 12th and 11th centuries. The combination of small subsistence territories, absence of political complexity and physical insecurity would make the production of subsistence surplus for regular exchange difficult to ensure. On the question of specialised herding,

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62 SANDERS (n. 27), 154.
63 A variation on the model of extensive agriculture described by HALSTEAD (n. 17). A few 18th- to 19th-century metochia belonging to the Monastery of Ayios Giorgos Epanosifis adjoined the Profitis Elias area. Sources relating to these record a focus on grain as well as vines (R. PASHLEY, Travels in Crete, Volume I (London 1837), 228; E. PETRAKIS, O Ayios Giorgios o Apanosifis (Istoria Mia Monis), KCh 10 (1956), 55–6.
64 See e.g. J.N. COLDSTREAM, Geometric Greece (Second edition) (London 1979), 88–9; J.N. COLDSTREAM and H.W. CATLING, Knossos North Cemetery: Early Greek Tombs (London 1996), 716–7; I. SAKELLARAKIS, Some Geometric and Archaic votives
neither the settlement pattern across Crete, nor local regional patterns, fit any kind of specialized herding model. That is, there is no clear differential pattern in location or altitude between groups of sites in any region, with some (we would expect smaller, less permanent ones) in the ‘core’ grazing zone and other main settlements, outside it. In the absence of such a system, there would be no herding-related reason for most sites to be at medium, rather than high average altitudes, but at the same time so generally difficult to access from nearby arable areas. The few sites which are located well within higher mountainous areas (Erga- nos Kefali, Karfi, Gonies to Flechtron, Tapes Kato Kas- tello, Loutraki Kandilioro, Males (Christos) Schistra) are often large and complex settlements, some with associated cemeteries affirming their long-term, stable use. In the Tapes case, the small size of Epano Kastello and its high altitude and defensibility might suggest a refuge place used by the inhabitants of Epano Kastello, but not a herding site (too close to the main site; un-necessarily inaccessible). In fact, neither the general or local patterns of settlement, the prevailing political and economic framework, limitations of the hinterland environments, nor the archaeofaunal data support specialised herding as characteristic of the LM III C economy.

Although new community relationships had to emerge in LM III C, LM III A–B socioeconomic structures and practices are likely to have left some kind of legacy to LM IIIA–B Crete, many of the hillslopes must already have been cleared and grazed. Stands of olives and vines probably existed in the vicinities of significant LM IIIA–B sites like Profitis Elias Vitsiles, Koxare Aloni (see above), Gournia, Milatos, Arvi Kamini and others which have LM III C settlements nearby, and these could have continued to be exploited. Even around Karfi, fields (though not olive plantations) must already have been well established by LM III A–B settlements on or around the Lasithi plain. In other areas, a more limited presence of LM III A–B small (farming-related?) settlement also suggests some predevelopment of the landscape around EIA sites – e.g. at Vrokastro, Praisos. Where demonstrates the perceived importance of lineage, with small communal tombs (some of which show the passing on of wealth through generations) common, as they had been in LM III A–B. There is other evidence that lineage or other forms of cohesive social identity structures were strong through the Cretan EIA – settlement continuity or very short-range movement between LM III C and PG–A; the strong role of public cult; the unrestricted consumption of high-value goods. But we should not be misled into assuming too much continuity with the LBA, given the kind of radical disjunction of relationships I have discussed, and this stability was generated within the EIA period, rather than passed on to it.

LBA land use-practices must partly have affected subsistence scope in LM III C. Given up to 500 000 sheep/goats involved in the large-scale herding systems of LM A–III B Crete, many of the hillslopes must already have been cleared and grazed. Stands of olives and vines probably existed in the vicinities of significant LM IIIA–B sites like Profitis Elias Vitsiles, Koxare Aloni (see above), Gournia, Milatos, Arvi Kamini and others which have LM III C settlements nearby, and these could have continued to be exploited. Even around Karfi, fields (though not olive plantations) must already have been well established by LM III A–B settlements on or around the Lasithi plain. In other areas, a more limited presence of LM III A–B small (farming-related?) settlement also suggests some predevelopment of the landscape around EIA sites – e.g. at Vrokastro, Praisos.

Fig. 13. Contour map of Profitis Elias area, showing EIA sites. Contour interval 20 m
relocated settlement was at a greater distance from previously-exploited arable areas, the latter could still be used by means of fieldhouses (e.g. the Lakkonia plain by the Tapes sites), or through links to other LM III C communities close to these areas – as in the cases of Monastiraki Katalimata and Kavousi Kastro, where nearby sites at Chalasmeno and Vronda could easily access the northern Ierapetra isthmus, settled and farmed in LM IIIA–B. Extensions of access to arable would be particularly likely where the carrying capacity of the new sites’ immediate hinterlands was limited. Nevertheless, a new subsistence infrastructure would still have to be built up within each sites locality if it did not already exist. At Tapes, for example, the lack of a major pre-existing settlement, and the limited quality of the arable land in the area, suggests little LM IIIA–B infrastructure is likely to have been in place, and more clearance, terracing and pathmaking must have been required, with a substantial input of time and labour. Parallels to this situation may have existed at Erganos Kefali, Mirthios Kirimianou and Kavousi Kastro.

Although, following the argument made above, the LM IIIA–B hierarchy of settlement – with centre(s), regional sub-centres (perhaps the base for economically semi-autonomous individuals/groups, or the collecting of produce on behalf of the centre(s)), villages, and single farmhouses, could no longer have operated, a new kind of regional and supra-regional functional hierarchy could in theory have

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**Fig. 14. Arable zoning in the Profitis Elias area**

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71 The contemporaneity, widespread character and profundity of this change argues against Whitley’s identification of two, non-articulated types of 12th- to 10th-century societal forms, related to different types of settlement (‘stable’ and ‘unstable’).
emerged in the 12th–11th centuries. However, close study does not suggest this to have been the case. While there appears to be a full descending range of site sizes (based on a sample of 48 estimated sizes out of c. 130 known settlement sites) their patterns of spatial distribution do not fit to any recognisable hierarchical structure (Figures 15 and 16). There appears to be a maximum size limit of 30 – 40 000 sq m (large villages), but a clustering in the small-medium village size range (10 – 15 000 sq m). Distribution of size groups is not geographically even and as with the other evidence reviewed above, suggests that defensible topography (with, always secondarily, access to arable land) strongly influenced both site location and size. A few special site functions probably apply in this period, paralleled in, and perhaps continuing from, LM III B (but undoubtedly operating within radically changed structures) – gateways/ports (Knossos (Katsambas/Amnisos); Chania); extra-settlement cult places (e.g. the Psychro, Idaean, Patos, Amnisos, Tsoutsoros caves, Katsoyme); small farmhouses (e.g. in the Ayios Vasilios, Vrokastro, Praios areas); even a few small herding sites (not part of the main settlement pattern) in the high Sfakia mountains and Kouroupas massif.

Small’s and Foxhall’s models for EIA mainland Greece, together with Haggis’s for Crete, provide a useful basis from which to discuss the relationship between settlement and socioeconomic systems at this time. All agree that changes in sociopolitical frameworks, rather than environmental or primary subsistence changes, gave rise to new economic priorities, which influenced the location, survival and development of EIA communities. While the mainland models argue that the communities most physically distant or structurally distinct from the old (collapsed) systems stood the best chance of survival/prosperity in the EIA, this is not clearly applicable to Crete. The range of settlement movement was much more limited here, and the shift was a deliberate act, with size, location and success at first very strongly influenced by factors of defensibility. Thus, successful EIA settlements varied greatly in their physical relation to the old centres. Some former centres continued in use and developed through the EIA (although with a greatly changed structural role), making the contrast between new and old less extreme than on the mainland. Proximity to old centres could prove an advantage in terms of economic infrastructure, but was not directly instrumental in the longevity of EIA settlement, any more than distance was. In social developments, too, there must have been less polarisation between old and new structures of authority. With the high degree of spatial reorganisation, such distinctions must have been difficult to draw and to maintain, and new sociopolitical structures could thus emerge more quickly and universally. Semi-autonomous groups partly disassociated from the centralised authorities, seem already to have played a significant sociopolitical role in LM III A – B, and this fact would facilitate the rapid formation of new, fairly stable community structures in the 12th century.

In view of the present study’s conclusions, Haggis’s characterisation of LM III C settlement as reverting to a basic subsistence ‘backbone’, in the absence of complex supporting structures, is not explanatory of the change...
itself. Self-sufficiency would indeed seem to have risen in importance at this time, but the shift did not take place in direct response to large-scale economic change, a fact most clearly demonstrated by the subtle differences in topography and hinterland character between LM III C settlement and that of other periods at which village-level self-sufficiency was the norm. In the case of Kavousi, the main low-lying kampos area is suggested by Haggis to have been fundamentally unattractive for cultivation, even under irrigation (an improvement most likely to be maintained by complex economic/political systems). Thus it was settled only in periods of complexity when such improvements were possible, and when political control of this territory, with its access to the coast, was crucially important. This, for Haggis, explains why settlement left the area in the changed circumstances of the 12th to 10th centuries. Yet my studies have shown that the areas of low-lying land in the vicinity of other EIA sites were often of the best arable quality in the region, well-able to be exploited within small-scale, low-investment economic frameworks, and regularly used for settlement in most other periods than the EIA. In this context the Kavousi example appears to be something of an anomaly.

My brief remarks about the abandonment of some of the studied sites by the PG period have tended to focus on subsistence-related factors – limitations on the carrying capacity of their arable hinterlands and on their opportunities for territorial expansion. However I do not believe that these were the only, or even the main, factors in this very significant settlement change, which was to play an integral, creative part in the rise of the polis. When considered together with other sites of their type and date, Vrachasi Anavlochos and the Profitis Elias sites also suggest a more complex picture than that drawn by Nowicki, of a ‘movement down’ to less defensible locations from PG onwards in response to a reduced threat of attack. Their common characteristics are not just a different type of defensibility (apparently based more on large-scale collaborative effort and strategic positioning than on intrinsically defensible topography) but a larger physical space for substantial settlement expansion, as well as the ability to control/exploit a larger political, as well as subsistence, territory than is true of the abandoned LM III C sites. Their locations also seem to reflect a growing concern with access to trade/communication routes (as other archaeological evidence for the PG – A confirms). The widespread distribution and common features of these long-lived sites, their lack of markedly large size, complexity or other special features during the 12th to 11th centuries, and the approximately simultaneous abandon-ment across the island of so many earlier defensible settlements, argue against the notion that different types of EIA settlement with different occupation spans represent significantly different, non-articulated social structures, and against aggressive takeover as the main or only mode of settlement expansion. The increasing size of the some settlements from PG, and the other factors they have in common, instead suggest that the process of nucleation was connected to the emergence of new forms of social authority and a changing, more con-solidated economic base: the roots of state formation.

My case studies show that the LM III C – SM settlement pattern can in no sense be seen as a ‘natural’ or ‘default’ one, determined by subsistence priorities or by hinterland potential, although these did play a role. Rather, settlement seems to have been directly instrumental in creating a new set of macroeconomic and social conditions into which subsistence production had to fit. Basic subsistence practices are not likely to have varied dramatically between LM III A–B and LM III C, but the scale and prioritisation of activities, the type and degree of investment in land improvement, the location of exploited areas, and the social and economic relations of the people engaged in production must all have done.

Explanatory notes

Land potential assessment methodology

Given the long-term flexibility in perceptions of what constitutes cultivation and grazing land in Crete, Bintliff’s categories of ‘poor grazing’ and ‘good grazing’, based very largely on current land use, appearance and soil characteristics, seem too direct in their assumptions from present-day to past land use. Here, I assessed the productive potential of all land in the 1-hour range of a site with regard to its potential for both herding-based and agricultural exploitation in the past, on the basis of the combination of data types discussed above. Grading criteria were applied consistently to all the case study areas. ‘First-class/prime arable’ refers to land which would be of the highest potential under a dry farming husbandry, World Archaeology 28/1 (1996), 20 – 42.

82 Like the areas of Kritsa Kastello, Mirsini Kastello, Kato Chorio Profitis Elias (where pre-existing settlement is likely, given the LM III A–B tombs found there). See NOWICKI 2000 (n. 1), 89; 120–3, 103–4; WATROUS (n. 1); IDEM, The Gournia Survey (forthcoming).
Fig. 15. Range of site sizes, based on estimates from surface scatters on 48 sites
Fig. 16. Site size frequencies, based on estimates from surface scatters on 48 sites
regime, possessing a combination of the following features: physical workability of soils; gentle gradient; evidence for intensive and regular historical/traditional use; (usually) relatively high chemical fertility. It was apparent, however, that the relative quality of the best arable land varied between the areas studied. For the present purposes this was not crucially distorting, although certainly, for example, very high quality arable like that of the Profitis Elias area is likely always to have been considerably more productive and to require less investment than the so-called ‘prime arable’ of the Tapes valley floor. ‘Second-class arable’ here is land which can be shown through the presence of certain cultural features to have been used as arable at periods in the past, and which may be used as such today, but is of a relatively thin-soiled, rocky and steep character, and has been less regularly- or intensively-used in the past than prime arable areas. ‘Probable second-class arable’ is land which has no apparent evidence for past cultivation, but which seems to be of very similar character to second-class arable in the same area. ‘Uncultivable’ areas are large extents of extremely thin soil or bare rock, with no evidence of past or present cultivation. The last category is the most difficult to soil or bare rock, with no evidence of past or present cultivation. The last category is the most difficult to grade, since geomorphological change may have reduced soil cover in some cases, but when gradient and land use history are taken into account, a little more support is lent to this designation. The last category is always much the smallest, and the tendency of the study has been to put land into the probable 2nd-class arable, rather than uncultivable, class where there is any chance to do so, rather than assume too much about past land-use or preferences. The result is to show the maximum possible cultivated area, with a margin of error which allows both for limited geomorphological change within a region. After assessing land potential, it was possible to work out approximate carrying capacity for the 1-hour range of each site. Dry farming, and the yields/requirements presented in Table 2 (based on traditional/historical agriculture), were assumed in each case. The calculations were as follows:

1. A maximum and minimum value for carrying capacity were calculated according to whether prime and second-class arable only were assumed to have been used, or probable second-class arable was also taken into account.

2. Second-class arable areas were halved in two of the alternative calculations, and probable second-class arable areas were halved in all of them, to allow for lower productivity in comparison with prime arable. This seemed to allow adequately for over-estimation of land potential and for necessary extra labour input on stony/steep land, although it is impossible to estimate for exact variability in productivity on different qualities of land. In all, 4 alternative calculations, assuming differing extents of agricultural land use, were made.

3. Carrying capacities for each 1-hour range were calculated allowing a maximum of 1.2 ha of land per individual on annual fallow rotation and assuming a 100% reliance on cereal produce (Table 2). The estimate of 1 ha of arable fallow needed to support a grazing animal was used, together with the estimated requirement for an individual on a mainly animal-product-based diet (of c. 50 animals),100 to add the number of individuals which could be sustained from herding on land in the 1-hour range (see discussion on the types of land assumed to have been grazed, above). Since all land which could be cultivated could also have been grazed, I produced maximal potential grazing figures by combining the area of cultivable land with uncultivable zones (excluding large expanses of rock). However, it might be argued that only cleared, cultivated fallow or excultivated land can be assumed to have been grazed, so a figure which assumes that only all potentially cultivable land was grazed was also calculated, although this is obviously rather an artificial one.

4. Bintliff’s argument for the average use of only 30–40% of hinterland carrying capacity at prehistoric sites was used to calculate an alternative figure.101 However, based on historical and ethnographic studies in Crete generally and in the case study areas, and in view of the high density of EIA sites in most of the areas studied (with their 1-hour ranges often overlapping each other), it seems better to assume an alternative, heavier use of local carrying capacity. Maximal use of the 1-hour range is also highly unlikely, however.

5. Population was assessed using a method proposed by Nowicki for LM III C – SM settlements with agglomerative plans.102 This method uses the excavated area of Karfi, with 25–30 houses and the estimation of 5–8 people per house, as the basis for suggesting c. 125–240 people per 6000 sq m of agglomerative architecture

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Table 2. Statistics and estimates on yields and consumption based on Allbaugh’s data on mostly traditional, i.e. unmechanised, farming in Crete

<table>
<thead>
<tr>
<th>Crop</th>
<th>Normal yield kg/ha</th>
<th>Kilocalories per ha</th>
<th>Kilocalories per kg</th>
<th>Quantity needed per person if 100% reliance (30% reliance)</th>
<th>Quantity needed per growing year if 100% reliance (30% reliance)</th>
<th>Ha needed per person if 100% reliance, assuming alternate fallow years and two-year fructifying cycle for olive, + 20% seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>604.2 (483.4)</td>
<td>39.52</td>
<td>3136.8</td>
<td>291</td>
<td>582</td>
<td>1.2 ha per person</td>
</tr>
<tr>
<td>Barley</td>
<td>742.4 (594.4)</td>
<td>243.64</td>
<td>3281.8</td>
<td>270</td>
<td>540</td>
<td>0.91 ha per person</td>
</tr>
<tr>
<td>Legumes</td>
<td>666.8 (532.4)</td>
<td>234.74</td>
<td>3520.5</td>
<td>239</td>
<td>518</td>
<td>0.97 ha per person</td>
</tr>
<tr>
<td>Olives</td>
<td>483.1 (514) = 140 trees</td>
<td>422.5410</td>
<td>3746.3</td>
<td>31.3</td>
<td>62.6</td>
<td>0.1 ha per person</td>
</tr>
</tbody>
</table>

(an estimate roughly paralleled by Morris’s calculations for Vrokastro and other EIA sites. The method is often problematic and needs to be used with caution, particularly when architecture does not appear to be agglomerative or a site is known only from surface sherd scatters. It seems to me unlikely that dwellings the size of those at Karfi regularly housed as many as 8 people, and the figure of 5 people per average-sized house seems more representative. For the sites studied here I therefore use a range based on a modification of Nowicki’s method, i.e. assuming 125 to 150 people per 6000 sq m of built area, with the reservations already mentioned.

Estimating the productivity of unmechanised agriculture and subsistence requirements per person

The calculations assume subsistence on one foodstuff alone and eating to fulfil caloric requirements rather for the host of other sociocultural reasons which complicate the way humans consume food. These assumptions are completely artificial, but provide the safest estimate of the maximum land areas needed for subsistence. The figures given represent the area of sowing needed to support an adult individual, assuming 100% reliance on cultivated crops. Thus, given an inevitable use of animal resources, a substantial margin of error is allowed. The figures can be considered in conjunction with traditional/historical family plot sizes, although these have been affected over time by various social and political structures. Gasparis, using primary sources from the early Venetian period, discusses the average size of peasant landholdings (0.9 – 1.8 ha in cereals, usually with additional areas under olives or vines) and the average yields obtained. For a holding of 1 vodi (c. 1.2 ha) he gives the average figure of 680 kg, with a seed-yield ratio of 1:4. Bintliff records average family plot sizes of 3.2 ha in traditional Crete. Further data

85 See HAGGIS 1992 (n.1).
87 There is a site recovery bias in east Crete, where a larger amount of research on this period has been carried out.
88 With most of the large sites known from the Lasithi area, including the flanks of the mountains and thus bordering parts of other areas, and probably from central Crete. Eastern Crete (the Siteia mountains area) is characterised more by small- to medium-sized sites, perhaps due to its broken (but good defensible) topography and limited pockets of arable. However there were a few large sites here too – Kalamafiki Kipia, Kato Chorio Profitis Elias (J. WHITLEY et al., Praisos III: a report on the architectural survey undertaken in 1992, BSA 90 (1999), 405 – 28; NOWICKI 2000 (n. 1); WATROUS (n. 1); IDEM (n. 75).
sources and published calculations supporting the estimates given in Table 2 are cited in the notes below.

1. Estimates by Garnsey on average subsistence requirements and cereal yield per ha in antiquity are as follows: wheat is suggested as having a yield of 625 kg/ha, barley 770 kg/ha, with a seed/yield ratio of 1:4 – 1:6 for these crops. He gives a figure of 175 kg of cereals per person per year for subsistence requirements, which is close to Osborne’s of 180 kg.

2. An estimate by Bintliff on average cereal yield per ha in traditional Crete is c. 807 kg per ha (derived from some of Allbaugh’s higher figures for Cretan yields, rather than the lower ones, and making little allowance for the completely unmechanised nature if ancient farming, the needs of fallowing and seed retention).

3. A range of primary and secondary estimates on cereal yields and requirements from traditional and historical farming in the southern Aegean, ranging from 590–900 kg for yields per ha and 110–287 kg for individual requirements, are collated by Davis.

4. Whitelaw suggests that 1.5 ha of arable would have been necessary to support one individual, even in the early 20th century, and that average cereal yield per ha would have been c. 340 kg/ha. The closest correspondence to the figure I have arrived at above is the estimates recorded by Halstead and Jones from farmers on modern Carpathos using traditional methods (not always including bare fallowing). These are 1.2 ha of cereals to feed one person per year. Assuming a roughly 70%: 30% balance of cereals and olive as major foodstuffs in the diet, a figure of about 0.94 kg per person per year is arrived at, slightly less if pulses formed a significant part of the diet.

5. Olives must be looked at in a slightly different way from cereals and legumes. Pashley noted that 150–200 trees are needed for 100 mistata, c. 625 kg. He suggested that an average family consumed 40 mistata (c. 250 kg) per year, with a mean of 15–20 mistata, the produce of about 30 trees. The average weekly oil consumption for a family is estimated at 4 okes minimum (5.12 kg) Examination of the data for 20th-century Crete presented by Allbaugh and by Bintliff suggests that c. 0.1 ha of olives per person should be allowed for where olive is a significant element in subsistence (up to 30% of caloric intake). Bintliff suggests about 1 ha of olives as average for a 7-person family under traditional systems.

**General subsistence parameters – exploited species known from the EIA**

Recent and forthcoming publication of botanical and fauna data from LM III C sites will allow us better to reconstruct the main features of subsistence strategies at different sites. The proportions in which various species were exploited depends much on contemporary socioeconomic frameworks, as discussed above. The amount of evidence presently to hand confirms the use through the EIA of the main LBA species – emmer, einkorn, olive, grape and fig. Almond is also known from LM III C–PG assemblages. As demonstrated (except where most of a settlement’s hinterland was above about 700 m, restricting the cultivation of olive), all would be cultivable at the new sites. A diverse range of livestock species is represented in several published or shortly-to-be-published LM III C faunal assemblages (Table 3); contrasts in their proportions between sites may relate to differences in landscape and/or local economic frameworks. Although sheep/goat is usually the most important species, a true pastoral economy is not demonstrated by any assemblage (supporting the discussion above, of settlement-level herding specialisation as unlikely to have characterised this period). Pig and cattle are better represented at low-lying sites with gentler topography, but the evidence from inaccessible, mount-ainous Kavousi and other sacred grottoes in Crete (Warsaw 1996); L. V. Watrous, The cave sanctuary of Zeus at Psychro. A study of extra-urban sanctuaries in Minoan and Early Iron Age Crete (Aegaeum 15, Lige 1996), 108–11; Sakellarakis 1987 (n. 64); N. KouroU and A. KaretsoU, To iero tou Ermou Kranaiou sto Patso Amariou, in Rocchetti (ed.), 81–164; Schäfer et al. (n. 86); S. Alexiou, Tsoutsouras, in: Archiologies kai menmeia (Nomoi Irakleiou kai Lasithiou): skafikai erenvai kai perisyloghi arxaiotita, AD 18, B’ (1963), 310–11.
Table 3. Faunal remains from EIA sites – proportions of main species (percentages)

<table>
<thead>
<tr>
<th>Site/date</th>
<th>Ovis/capra (%)</th>
<th>Sus (%)</th>
<th>Bos (%)</th>
<th>Others (list)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kavousi Kastro (mostly LM III C–FG)</td>
<td>322</td>
<td>7.7</td>
<td>8.6</td>
<td>Horse (<em>Equus</em> (&lt; 1%)); fallow deer (<em>Dama dama</em> (&lt; 1%)); agrimi (<em>Capra aegagrus</em>) (&lt; 0.1%); dog (<em>Canis familiaris</em>); small quantities of hare (<em>Lepus sp.</em>); badger (<em>Meles meles</em>); and other small wild species, shellfish.</td>
</tr>
<tr>
<td>Kavousi Vrouda LM III C</td>
<td>76</td>
<td>15.9</td>
<td>5</td>
<td><em>Equus</em> (17%); <em>Capra aegagrus</em>; <em>Canis</em>, <em>Lepus</em></td>
</tr>
<tr>
<td>Monastiraki Chaledonos LMIII C</td>
<td>729</td>
<td>16.7</td>
<td>5.2</td>
<td><em>Equus</em> (2.1%); <em>Canis</em></td>
</tr>
<tr>
<td>Chanaëvri LM III C</td>
<td>413</td>
<td>15</td>
<td>7.4</td>
<td>Indeterminate medium mammals (15.7%); indeterminate large mammals (3.6%); <em>Equus</em> (1.3%); <em>Dama</em> (1.4%); <em>Capra aegagrus</em> (red deer) (1.3%); indeterminate deer (0.3%); wild <em>Sus scrofa</em>; <em>Bos primigenius</em>, <em>Canis</em>, <em>Lepus</em>, <em>Meles</em></td>
</tr>
<tr>
<td>Chania LM III C</td>
<td>56</td>
<td>26</td>
<td>9</td>
<td><em>Equus</em>, <em>Dama</em>, <em>Capra aegagrus</em> (all percentages unspecified)</td>
</tr>
<tr>
<td>Kommos Temple A (SM–FG)</td>
<td>55</td>
<td>10</td>
<td>35</td>
<td><em>Lepus</em>, <em>Capra aegagrus</em>; marine shellfish (all individually quantified)</td>
</tr>
<tr>
<td>Other SM–FG in Kommos sanctuary area</td>
<td>556</td>
<td>0</td>
<td>44</td>
<td><em>Lepus</em>, marine shellfish (all individually quantified)</td>
</tr>
</tbody>
</table>

Kastro also shows a surprisingly high proportion of cattle to have been butchered on the site.

**Soil analysis methods**

The value and limitations of the types of analyses carried out here are discussed in various basic texts, and summarised in the table below. It was useful to compare results with others obtained for Crete by Nevros and Zvorykin, Bintliff, and Morris. The work was carried out in the Soil Science Laboratory of the Department of Geography, University of Edinburgh and some results were analysed by the Department of Chemistry, University of Edinburgh.

91 MOODY, pers. comm.
92 SMALL (n. 78); L. FOXHALL, Bronze to iron: agricultural systems and political structures in Late Bronze Age and Early Iron Age Greece, BSA 90 (1995), 239–50; HAGGIS 1993 (n. 1).
93 Contra Foxhall's thesis for mainland Greece.
94 DRIESSEN (n. 86); J. BENNET, 'Collectors' or 'owners'? An examination of their possible functions within the palatial economy of LM III Crete, in OLIVIER (ed.) (n. 86), 159–67; P. CARLIER, Les collecteurs sont-ils des fermiers? in OLIVIER (ed.) (n. 86), 65–103.
95 Small suggests a similar situation for the mainland. See SMALL (n. 78).
98 As argued by WHITLEY 1991, Social diversity... (n. 2).
99 BINTLIFF 1977, Natural environment... (n. 10), 605–67; see his note of caution, 626.
Methods

pH was measured, using an electrometer, of a suspension of 10 g of soil in 25 ml of distilled water. Carbonate content was measured using a carbonate ‘bomb’ where the reagent was 6N HCl used with 0.72 g of dry soil. CEC measurement was carried out by measuring concentrations of K, Ca, Na and Mg in samples of 5 g of soil extracted in 125 ml 1M Ammonium acetate. K and Na were measured by flame photometry and Ca and Mg by atomic absorption spectrometry. Quantification of water-holding ability and particle size analysis, valuable in land potential assessment and used in Morris’s studies, could not be carried out within the scope of my study.

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Table 4. Composite table of soil analyses. (This is a heavily simplified table: a fuller range of soils types were in fact mapped at the level of 0.25 ha units, sampled, and analysed in each study area).

<table>
<thead>
<tr>
<th>Soil type code</th>
<th>Group</th>
<th>% of 1-hour range</th>
<th>pH</th>
<th>Carbonate%</th>
<th>K m.e.</th>
<th>Na m.e.</th>
<th>Mg m.e.</th>
<th>Ca m.e.</th>
<th>CEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>C5 Frefi</td>
<td>Hard limestone-derived terra rossas</td>
<td>22.8</td>
<td>5.59</td>
<td>0</td>
<td>0.65</td>
<td>0.09</td>
<td>5.11</td>
<td>1.10</td>
<td>6.95</td>
</tr>
<tr>
<td>C15 Frefi</td>
<td>Hard limestone-derived terra rossas</td>
<td>2.1</td>
<td>6.85</td>
<td>0</td>
<td>0.80</td>
<td>0.18</td>
<td>50.40</td>
<td>1.73</td>
<td>53.11</td>
</tr>
<tr>
<td>C20 Frefi</td>
<td>Hard limestone-derived terra rossas</td>
<td>0.95</td>
<td>7.08</td>
<td>0</td>
<td>0.51</td>
<td>0.32</td>
<td>20.08</td>
<td>2</td>
<td>22.91</td>
</tr>
<tr>
<td>D1 Anavlochos</td>
<td>Hard limestone-derived terra rossas</td>
<td>48.5</td>
<td>2</td>
<td>7.33</td>
<td>2.24</td>
<td>0.28</td>
<td>37.63</td>
<td>8.33</td>
<td>68.5</td>
</tr>
</tbody>
</table>

100 HALSTEAD 1996 (n. 81), 34; IDEM, From determinism to uncertainty: social storage and the rise of the Minoan palace, in A. SHERIDAN and G. BAILEY (eds), Economic archaeology: towards an integrated approach (BAR Int. Series 96, Oxford 1981), 204; IDEM,
<table>
<thead>
<tr>
<th>Soil type code</th>
<th>Group</th>
<th>% of 1-hour range</th>
<th>pH</th>
<th>Carbo-</th>
<th>K m.e.</th>
<th>Na m.e.</th>
<th>Mg m.e.</th>
<th>Ca m.e.</th>
<th>CEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1 Knitsa</td>
<td></td>
<td>62.2</td>
<td>7.15</td>
<td>0</td>
<td>1.93</td>
<td>0.34</td>
<td>11.10</td>
<td>1.71</td>
<td>15.08</td>
</tr>
<tr>
<td>G2 Tapes</td>
<td></td>
<td>77.1</td>
<td>7.66</td>
<td>2</td>
<td>0.37</td>
<td>0.31</td>
<td>45.72</td>
<td>1.84</td>
<td>48.24</td>
</tr>
<tr>
<td>X2 Pr. Elias</td>
<td></td>
<td>6.6</td>
<td>7.98</td>
<td>76</td>
<td>0.92</td>
<td>1.27</td>
<td>8.40</td>
<td>641.47</td>
<td>652.12</td>
</tr>
<tr>
<td>D3 Anavlochos</td>
<td></td>
<td>3.85</td>
<td>14</td>
<td>7.26</td>
<td>0.61</td>
<td>0.30</td>
<td>50.40</td>
<td>13.25</td>
<td>64.56</td>
</tr>
<tr>
<td>E3 Knitsa</td>
<td></td>
<td>4.2</td>
<td>7.57</td>
<td>32</td>
<td>0.40</td>
<td>0.27</td>
<td>410.93</td>
<td>21.8</td>
<td>414.08</td>
</tr>
<tr>
<td>G2/G3 Tapes</td>
<td></td>
<td>5.5</td>
<td>7.52</td>
<td>32</td>
<td>0.23</td>
<td>0.38</td>
<td>320.61</td>
<td>1.98</td>
<td>323.20</td>
</tr>
<tr>
<td>X3 Pr. Elias</td>
<td></td>
<td>1.2</td>
<td>8.06</td>
<td>4</td>
<td>0.6</td>
<td>2.66</td>
<td>4.93</td>
<td>641.40</td>
<td>648.96</td>
</tr>
<tr>
<td>C6 Frati</td>
<td>Phyllite/phylite flysch-derived</td>
<td>41.8</td>
<td>6.47</td>
<td>0</td>
<td>0.09</td>
<td>0.93</td>
<td>6.24</td>
<td>1.24</td>
<td>8.50</td>
</tr>
<tr>
<td>C7 Frati</td>
<td></td>
<td>5</td>
<td>6.88</td>
<td>0</td>
<td>0.46</td>
<td>0.16</td>
<td>10.10</td>
<td>2.26</td>
<td>12.98</td>
</tr>
<tr>
<td>C8 Frati</td>
<td></td>
<td>2</td>
<td>5.61</td>
<td>0</td>
<td>0.07</td>
<td>0.12</td>
<td>1.15</td>
<td>0.72</td>
<td>2.06</td>
</tr>
<tr>
<td>D6 Anavlochos</td>
<td></td>
<td>41.8</td>
<td>25</td>
<td>7.04</td>
<td>1.21</td>
<td>0.32</td>
<td>63.70</td>
<td>5.40</td>
<td>70.63</td>
</tr>
<tr>
<td>E2 Knitsa</td>
<td></td>
<td>14.7</td>
<td>6.75</td>
<td>0</td>
<td>0.17</td>
<td>0.22</td>
<td>21.96</td>
<td>2.42</td>
<td>24.77</td>
</tr>
<tr>
<td>E12 Knitsa</td>
<td></td>
<td>8.3</td>
<td>6.59</td>
<td>2</td>
<td>0.25</td>
<td>0.13</td>
<td>31.19</td>
<td>1.46</td>
<td>33.03</td>
</tr>
<tr>
<td>G6 Tapes</td>
<td></td>
<td>7.3</td>
<td>7.01</td>
<td>3</td>
<td>2.00</td>
<td>0.18</td>
<td>323.6</td>
<td>2.03</td>
<td>328.81</td>
</tr>
<tr>
<td>C9 Frati</td>
<td>Plain/valley floor mixed colluvium</td>
<td>9.6</td>
<td>7.26</td>
<td>12</td>
<td>1.01</td>
<td>0.19</td>
<td>162.05</td>
<td>2.60</td>
<td>165.83</td>
</tr>
<tr>
<td>C10 Frati</td>
<td></td>
<td>3.6</td>
<td>6.37</td>
<td>0</td>
<td>0.42</td>
<td>0.13</td>
<td>12.10</td>
<td>2.90</td>
<td>15.55</td>
</tr>
<tr>
<td>E10 Knitsa</td>
<td></td>
<td>6.9</td>
<td>7.22</td>
<td>3</td>
<td>2.27</td>
<td>0.37</td>
<td>32.99</td>
<td>3.56</td>
<td>42.49</td>
</tr>
<tr>
<td>E4/E8 Knitsa</td>
<td></td>
<td>1.7</td>
<td>7.57</td>
<td>22</td>
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<td>0.78</td>
<td>336.08</td>
<td>4.35</td>
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<td>X3(1) Pr. Elias</td>
<td></td>
<td>2.8</td>
<td>8.23</td>
<td>11</td>
<td>0.61</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>X4 Pr. Elias</td>
<td>Marl-derived</td>
<td>22.5</td>
<td>7.87</td>
<td>65</td>
<td>0.34</td>
<td>0.27</td>
<td>4.07</td>
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<td>458.07</td>
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<tr>
<td>X5 Pr. Elias</td>
<td></td>
<td>62.5</td>
<td>7.90</td>
<td>17</td>
<td>0.47</td>
<td>0.27</td>
<td>1.13</td>
<td>391.09</td>
<td>392.96</td>
</tr>
</tbody>
</table>