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Gert von Bally *Laboratory of Biophysics, Institute of Experimental Audiology, University of Münster, Robert-Koch-Str. 45, D-48129 Münster, Germany*

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The Role of Science in Archaeological Regional Surface Artefact Survey

John Bintliff,
Department of Archaeology, Durham University,
Durham, U.K.

My purpose in this paper is to address the question - how far today is the scientific field archaeologist, utilizing essentially surface remains, able to approach the complex behaviour of past peoples in space which the imaginative reconstructions of Classicizing painters such as Lorraine and Poussin present to us? (Fig. 1) I shall be using mainly Greek examples, to answer that challenge.

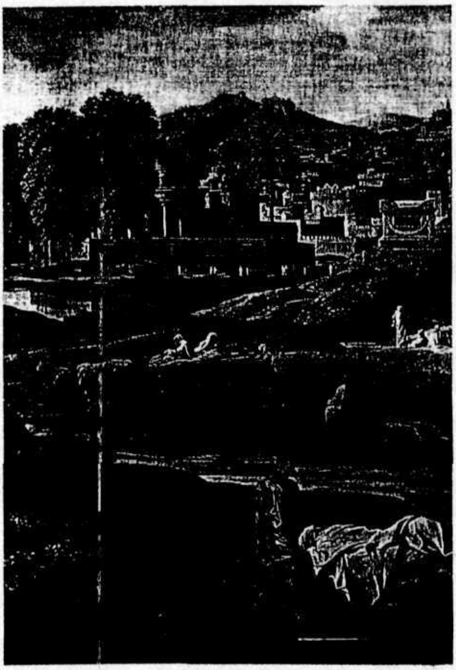


Fig. 1: The Burial of Phocion, by Poussin.

The Development of Extensive Survey

By the late Nineteenth Century, skilled topographers such as Lolling [1] (1876-7) were travelling exhaustively along the byroads and paths of South European countries, noting every standing ruin of every age. Maps such as *the Atlas de la Grèce* (1852) record both modern settlements, ancient ruins and deserted villages of post-Medieval date. But essentially these researches record the more obvious, larger archaeological sites where walls or mounds of rubble and tile were visible even at some distance. Only gradually was the idea being put into practice where the fieldworker wandered around small areas of landscape looking for more vestigial traces of settlement - notably those where only surface pottery betrayed past settlement and activity. An excellent example was being provided by German scholarship, where the importation of the flourishing tradition of *Landschaftsarchäologie* with its concern for the shifts of settlement within definable *Siedlungskammer* produced pioneering papers on the long-term utilisation of small landscapes, which were sadly to be neglected till very recently (e.g. Lehmann, [2]). With the retreat of German scholarship in the postwar era, American influences and examples came to the fore. A new standard for regional field survey was set by the massive University of Minnesota Expedition to the province of Messenia [3]. A very large region of the south-west Peloponnese was extensively travelled over, whilst both ceramic and standing monument surveys were conducted. The focus was especially on the Bronze Age settlements, but a striking novelty lay in the great range and depth of the interdisciplinary scientific contributions to the final project volume, chiefly in the realms of physical and human geography. Notably at around the same time, a similarly exemplary, largescale regional survey was setting a new standard in extensive survey for Italy - the British survey of South Etruria in Italy [4].

The Intensive Survey Revolution

Methodological debate in the United States, especially associated with the theoretically-orientated 'New Archaeology' movement, led during the 1960s to a demand for far more rigorous modes of landscape study, in order to allow evaluation of the total number and nature of activity and settlement traces of each period across defined areas of the landscape. This meant the use of lines of fieldwalkers some 5 to 50 metres apart, walking large continuous areas of countryside and trying to record all surface traces of past behaviour - especially bits of broken pottery. As in the States, it was quickly shown that these 'intensive' surveys found an incomparably higher number of sites per square kilometre than previous approaches. At first, generally following American schemes, regions were sampled using a scatter of survey blocks, or strips separated by unsurveyed land; total survey was carried out in the sample units, then their results provisionally extrapolated to the remaining countryside on the assumption of their representativity (e.g. on the Melos Survey, one-fifth of the island was fieldwalked in parallel 1-km wide strips each 5 kilometres apart) (Fig. 2)[5].

Whilst this approach dominated projects carried out in the 1970s and early 1980s, it was gradually being realized that the use of such sampling lacked empirical justification and was primarily being done to allow the study of large areas within a few seasons of research. Settlement patterns known historically were seen to be irregular rather than regular, whilst sampling systems worked much better for landscapes with innumerable, well-dispersed settlements than for landscapes wher most people lived in a few nucleated sites. Moreover, further theoretical an empirical experiments in the States had shown that in long-occupied landscapes th surface archaeology could reveal not only very small occupation sites but also places

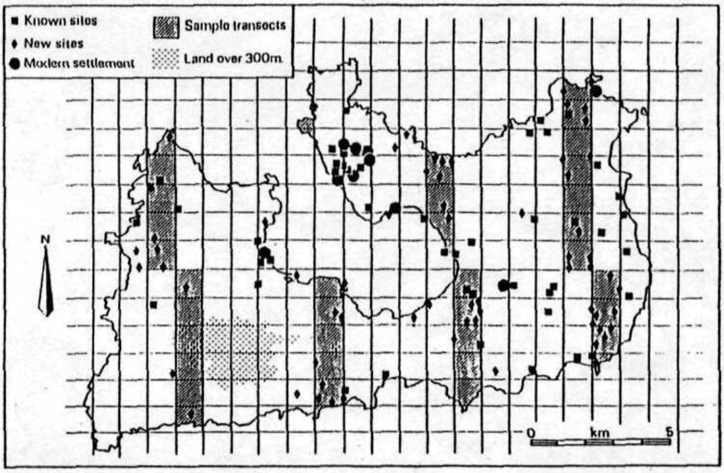


Fig. 2: The 20% sample scheme adopted for the Melos Survey (from [5] fig.2.1)

of non-residential activity ('offsite activity'). Clearly the surface of the countrysid was much more complex and unpredictable than had been imagined, and the best response was to slow down the speed of survey teams, and attempt to fieldwalk as close to 100% of the landsurface as possible. Moreover, as the concept was spreading of the entire landsurface as a human 'artefact', blurring the distinction between 'site-settlement' and a varying intensity of human behavioural traces beyond settlements (offsite scatters), a new methodology was required to record the entire surface. On my own project, the British Academy Boeotia Project (co-directed by Anthony Snodgrass of Cambridge University), in 1980 we adopted hand-held 'clickers' or manual counting devices, so that each fieldwalker could count every visible artefact in their path as they marched across the gridded landscape. Areas where the surface finds were very high or very fresh, or accompanied by building or other dense-activity debris, were revisited as potential 'sites' - and increasingly we were able to differentiate villages, farms, and rural cemeteries from each other [6] [7].

Gridding the entire landscape so that all of its surface archaeology was mapped was an approach many projects also adopted for the individual site found within the fieldwalking grids, so that the patterning of surface artefacts across the landscape could be followed into the microscale, complex variable patterning around and across settlement sites within those landscapes. By the end of the 1980s the advent of inexpensive hand-held computers and of Geographical Information Systems (GIS) offered ideal opportunities for adapting such intensive recording systems to the investigative power of elaborate spatial analytical software programmes. The search for patterns in surface landscape data and their matching to every kind of spatial variable now became a relatively simple task. I shall return later to the potential of GIS in the conclusion to this paper.

Correction Factors

Relying essentially on the surface discovery and plotting of artefacts raises problems of surface visibility; fields may be covered with crops, or freshly-ploughed, or fieldwalking may take place beyond the cultivated land in scrubland and woodland. As is well-known, surface artefacts derived from past sites are usually the result of regular ploughing of the subsurface disturbing archaeological levels, so that both the current and recent treatment of the soil and its degree of vegetation cover will seriously affect the density of artefacts found on the surface of ancient activity areas. A simple but effective way to allow for these variations is to take 'visibility readings' of the landsurface for each stretch ('transect') or field that is walked, reflecting numerically the percentage of the soil visible to the fieldwalkers. The count of surface artefacts can be given subsequently not only as a 'raw' density, but through multiplication using the visibility factor a more realistic corrected density can be mapped (Figs. 3-4; from [8]).

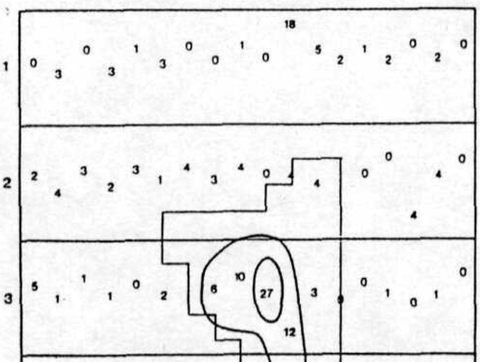
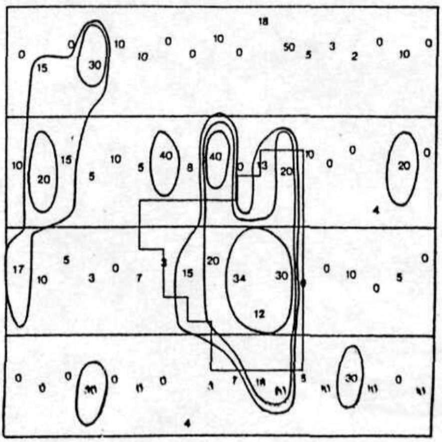


Fig. 3: Fieldwalking transects on the Hvar (Croatia) Survey, raw counts of surface pottery along individual north-south strips each 45m long and 1m wide. A clear anomaly in the centre of this sector suggests a settlement site (from [8] fig.9.7a).

The instability of the soil over time should also be investigated. Especially in Southern Europe, processes of erosion and deposition are widespread, giving different sectors of the same landscape a very variable soil development from ancient and prehistoric times to today. In some areas erosion may result in high site visibility, with very little left beneath the soil; in others more stable soil development may limit disturbance of buried deposits to thin scatters on the surface; in yet other areas, colluvial or alluvial deposition may partially or completely seal ancient landsurfaces and prevent sites from being made visible by ploughing. The services of a geomorphologist and soil scientist are seen today as essential to map in advance the



SITE P4 FIELD TRANSECTS, Visibility corrected

Fig. 4: The same sector as Figure 3, but with surface ceramic counts corrected for variable surface visibility. The settlement site is more clearly defined and more extensive, but there is another minor anomaly to be studied. Detailed site survey confirmed that the main anomaly was a large Roman villa (from [8] fig.9.7b)

distribution of such 'taphonomic' types, so as to avoid misleading inferences on the apparent density of activity as it appears today being a simple reflection of past activities (cf. [9]).

A further observation follows from what has just been said about erosion, deposition and cultivation disturbance to archaeological landsurfaces; over time one may expect that settlements and other activity areas suffer progressive attack by both natural and human weathering processes. Other things being equal, this means that a typical farmsite of High Medieval times will be better preserved on the surface and in the subsoil than one of Classical Greek times, whilst the same small farm of Early Bronze Age date will very likely be found in an extremely vestigial or minimal condition today. Figures 5-7 illustrate this using a small ancient farmsite in the Valley of the Muses in Boeotia: the first figure shows the total density of surface pottery per square metre, the second the number of securely-dated Classical sherds, the final that of Late Bronze Age pottery. The reasonable number of Classical pieces is typical for a small farm in this period, but the cluster of diagnostic Mycenaean pottery, despite its apparent insignificance probably points to a vestigial farmsite of a thousand years earlier.

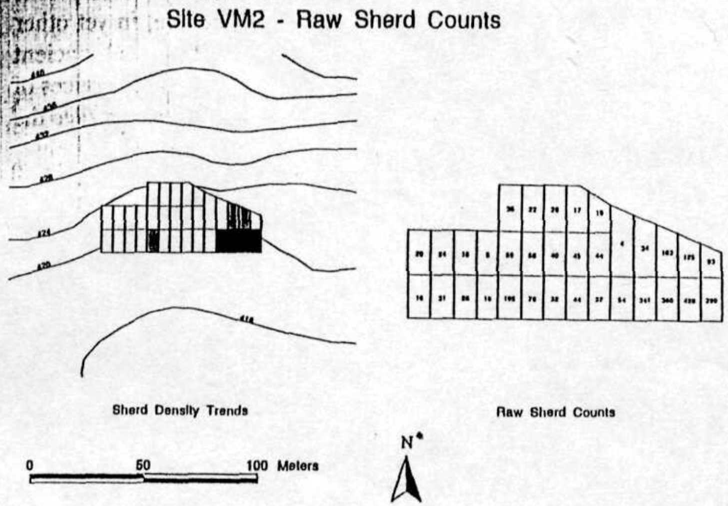


Fig. 5: Site VM2 in the Valley of the Muses, Boeotia, Greece. Raw counts of surface ceramic density in 7.5x10m sample units across the site. A clear focus for the likely habitation centre is seen at the eastern end.

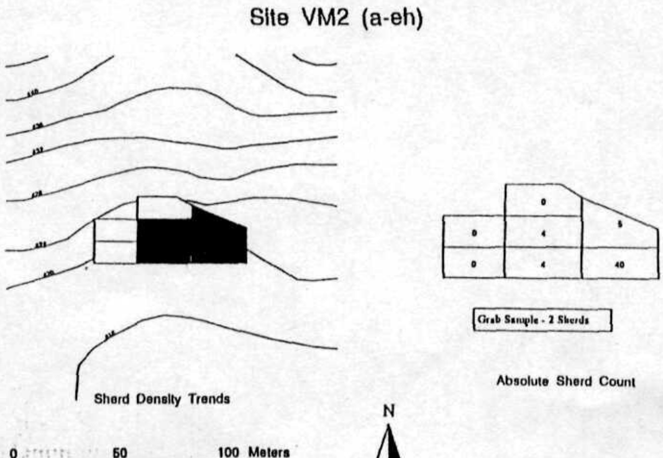


Fig. 6: Site VM2, with the distribution of definite Classical Greek pottery across the surface site. The far east sector is clearly highlighted as the likely location of an ancient family farmhouse.

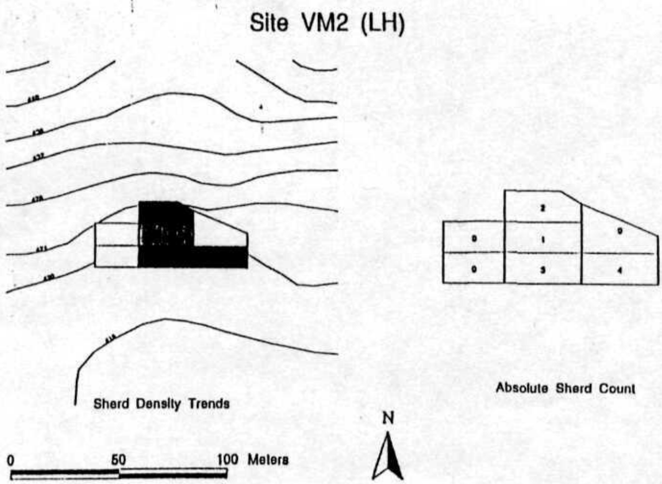


Fig. 7: Site VM2, with the distribution of definite Late Bronze Age pottery across the surface site.

Even with these correction factors for likely distortions in the surface record, a true scientist will want to see a degree of testability to the results. How can we tell if we are reconstructing a realistic countryside? Two examples will illustrate complementary ways of bringing independent evidence to verify settlement histories derived from surface artefact data. In the territory of one of the ancient Greek colonies of Southern Italy, a team directed by Joe Carter has excavated two cemeteries which are contemporary to a Classical settlement pattern revealed by intensive surface survey (Fig. 8; after [10]); the demographic rise and fall of population appears as a mirror-image in the two sets of data, except that the cemetery records the decline one or two generations after the settlements decline. The latter observation is a consequence of the later burial of those involved with settlement retraction phenomena, and perhaps resettlement of population outside the area.

A second example comes from my own project in Boeotia. During the C15th-C17th AD plentiful surface pottery from deserted villages allow us to reconstruct a full settlement pattern across the countryside [11]. Fortunately this era coincides with the early phase of the Ottoman Empire in Greece, where extremely careful tax records were kept of every community. We are able to make direct comparison between the number and size of villages from surface archaeology and contemporary tax records (Fig. 9) and find a very good match.

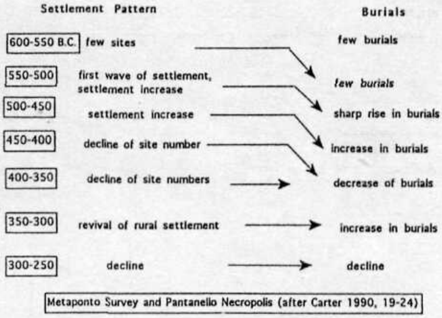


Fig. 8: Correlation between the rural settlement dynamic and burial numbers in the associated Pantanello cemetery in the territory of ancient Metapontum, southern Italy (chart prepared by K. Sbonias, based on [10]).

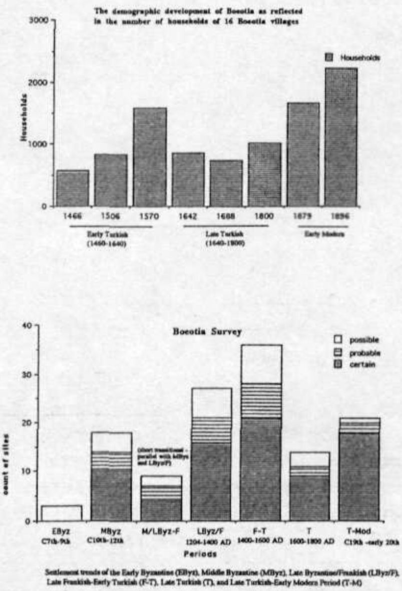


Fig. 9: A comparison of demographic developments in the province of Boeotia during post-Medieval times, Greece, based on Ottoman Imperial archives (upper chart, after Dr. M. Kiel), and archaeological surface survey (lower chart).

Probing the Secrets of the Subsoil using Geochemistry and Geophysics

Another way in which we can clarify the evidence gathered, purely from surface artefact distributions, is to enlist the aid of several scientific techniques to investigate human activity traces in the surface and immediate subsurface deposits in a non-destructive and inexpensive way.

Human activity is associated with an immense accumulation of organic and inorganic residues - what today we would call 'pollution'. Ancient populations often used such waste materials to increase the fertility of their fields through the process of intensive manuring derived from household and farmyard rubbish. Adjacent to and east of the ancient Boeotian city of Hyettos, for example, lies an extensive plain. Mapping of surface artefacts across its surface shows a dense carpet of broken pottery that must reflect continous, largescale transport of city rubbish onto the plain (Fig. 10). Tony Wilkinson has shown that the radius of such manuring is a direct reflection of the population size of the settlement concerned (Fig. 11) [12].

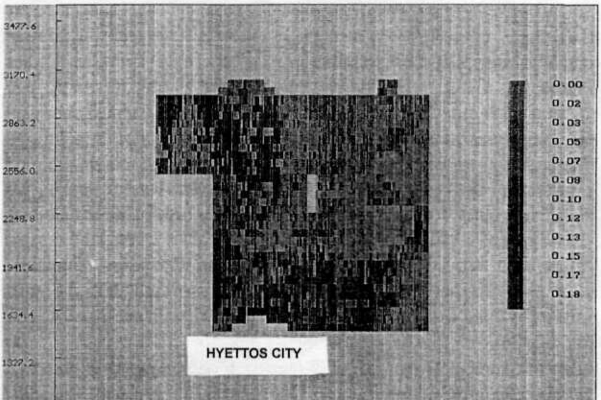


Fig. 10: The density per square metre of surface pottery in the immediate vicinity of the Greco-Roman city of Hyettos, Boeotia, Greece. The dense carpet of ceramics directly north-east of the town marks the main cultivable plain in its territory.(GIS by Dr. M.Gillings, author's data).

Clearly the inorganic broken ceramics have found their way into the soil alongside larger quantities of organic waste which have now been merged into the subsoil. This is the basis for a research programme into the soil chemistry of archaeological on-site and off-site sediments which we began in the 1980s on the

The approximate radius of significant field scatters surrounding archaeological sites in the Middle East (total sample: 19 settlements).

Settlement size	*Radius of scatter (km)*
Hamlets and farmsteads <1.5 ha	0.2–0.4
Villages 2–9 ha	0.6–1.0
Small town* 10–29 ha	1.3
Large town/city >40 ha	2.2–6.0

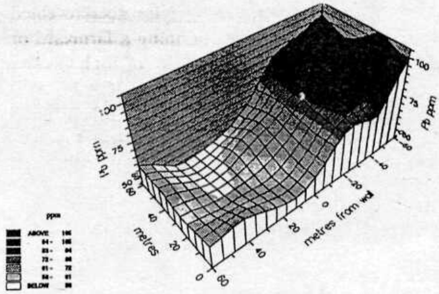
*One example only: site 48 in the North Jazira.

Fig. 11: Correlation between settlement size and manuring radii in the ancient and prehistoric Middle East (from [12] Table 1).

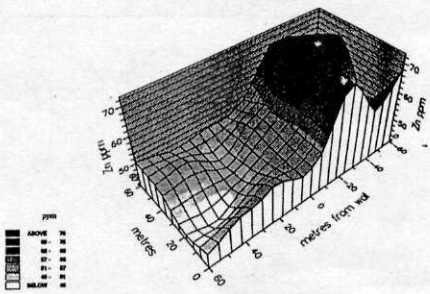
Boeotia Project, in collaboration with Professor Brian Davies of Bradford University Environmental Sciences Department, work which is currently being continued by Neil Rimmington in the Archaeology Department at Durham University. Professor Davies had specialized in mapping modern pollution pathways from mines and other industrial installations into the surrounding countryside, and during this work had discovered that all areas of human habitation showed soils with enrichened chemical elements - whether there was industrial waste or not. Analysing garden soils and comparing their content of trace element metals against the age of the garden revealed a steady increment in these chemicals over time - what Davies dubbed the 'habitation effect'. Clearly this research suggested that pre-Industrial settlements ought also to be associated with enhanced soil chemicals of certain kinds, and on this basis our programme with ancient Greek settlements began. The areas of ancient offsite manuring do show higher levels than regional background, but the soils across ancient cities show even more dramatic rises in trace metals such as Copper, Lead and Zinc (Fig. 12) [13].

Even small farmsites of Greco-Roman date, with several hundred years of occupation, show detectable accumulations of trace metals in their subsoils. However, once we had established that the Habitation Effect was typical for all periods of the past, and the elements concerned were tied in a stable form to the clay fraction of the soil, the mere confirmation of Davies' hypothesis was replaced by a deeper search for patterning in the dispersal of chemically-defined waste on ancient sites. A current focus of our research will illustrate the potential of such work. Site VM70 in the Boeotian Valley of the Muses is a typical Classical Greek farmsite. Its surface ceramic plot (Fig. 13) reveals an inner dense zone and a surrounding high-density zone (we call this a 'halo'), whilst the inner zone also had a dense area of rooftile indicating that here lay the main farmbuilding.

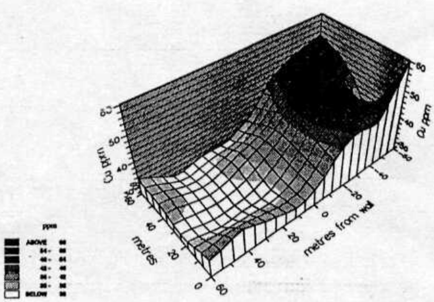
Intensive geophysical investigations using a resistivity technique (by Chris Gaffney, Mark Gillings and Neil Rimmington) showed an excellently clear plan (Fig. 14) focussing on a large, square, multi-roomed farmhouse in the very centre of



Surface soil lead concentrations at Thespiae.



Surface soil zinc concentrations at Thespiae.



Surface soil copper concentrations at Thespiae.

Fig. 12: The transformation in the values of trace metals in surface soil along a transect running from outside the ancient city wall to inside the city, at the Greco-Roman town of Thespiae, Boeotia, Greece (prepared by N. Rimmington from data of Prof. B. Davies, cf. [13]).

the tile and densest ceramic spreads. However the resistivity plot also revealed evidence for a large enclosure ditch on all sides of the farm, defining a farmyard or garden zone, which had already been suggested through the 'halo' of high density ceramic on the surface. Trace element analysis of the soils using ICP by Neil Rimmington (Fig. 15) shows a high accumulation of lead over the farmhouse and high phosphate readings in and around the suspected enclosure ditches.

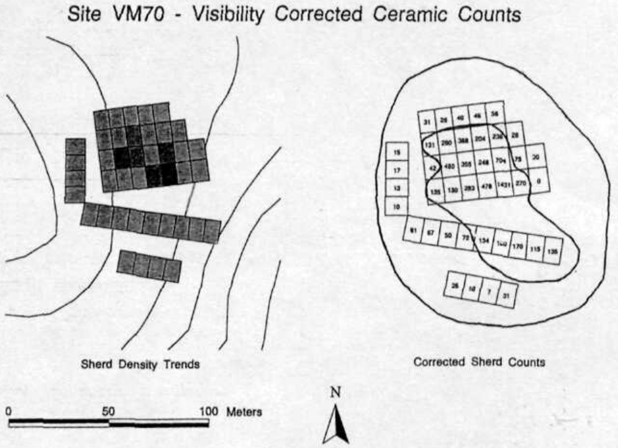
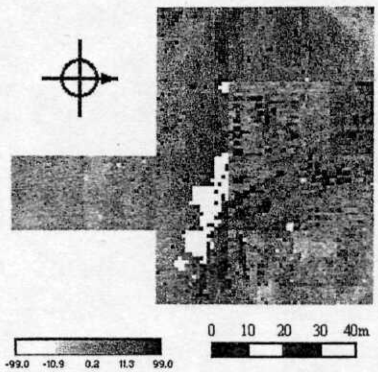


Fig. 13: The surface site VM70 in the Valley of the Muses, Boeotia, Greece. The surface ceramic density across the site, corrected for visibility, reveals a site core of very high values and a zone of medium to high intensity around it. A separate plot of tile debris on the surface also correlated closely with the inner sector, suggesting that the main dwelling structures of this Classical Greek farmhouse were located here.

Soil Resistivity Survey at VM70



Interpretation of Results

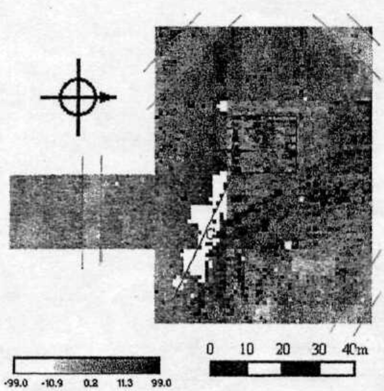


Fig. 14: A geophysical (electrical resistivity) survey carried out across site VM70. The elaborate rectangular and multi-roomed farmhouse in the core of the site is readily distinguishable, confirming that the inner highest ceramic density zone with its tile focus indeed overlies the dwellinghouse. However there are also strong indications on the south, south-west, north-east and north-west corners of the plot of an enclosing ditch system; this would very closely match the outer boundaries of the next zone of medium to high surface ceramics and would correspond to a farmyard or garden zone (research of C.Gaffney, M. Gillings, N. Rimmington for the Boeotia Project).

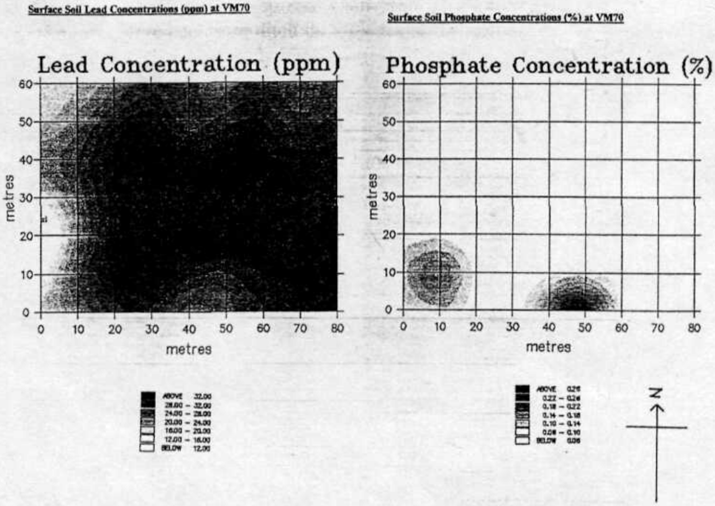


Fig. 15: Soil values for trace metal lead and phosphate across the main rectangle covered by the electrical resistance survey of Figure 14. The focus of lead corresponds to the location of the farmhouse, whilst the phosphate appears to be associated with the general zone of the putative enclosure ditches surrounding the settlement (research by N. Rimmington for the Boeotia Project).

Historical Interpretation

At the conclusion of an intensive regional surface survey, one can create histograms showing the fluctuations of site numbers against time (Fig. 16; after [14]). Allowing for the variable sizes of sites and the problem of whether all settlements were contemporary within a given phase, and provided that care is taken in trying to convert the area of a surface site to a likely number of inhabitants, such histograms can be used to chart the ebb and flow of regional demography. Such exercises, especially if town is compared with country population, may only be providing general order figures rather than exact and indisputable numbers, yet they are probably the best source of information we have about the behaviour of regional communities on the long timescale.

Thus in Greece, survey has cut through a long dispute from the literary evidence concerning the prosperity or otherwise of the Early Roman period, by showing a massive depopulation of rural sites and shrinkage of city areas at this time (see Figures 17-18 for a rural area in the Argolid, after [15]; Figures 19-20 for the shrinkage of the Boeotian city of Hyettos, from my own project).

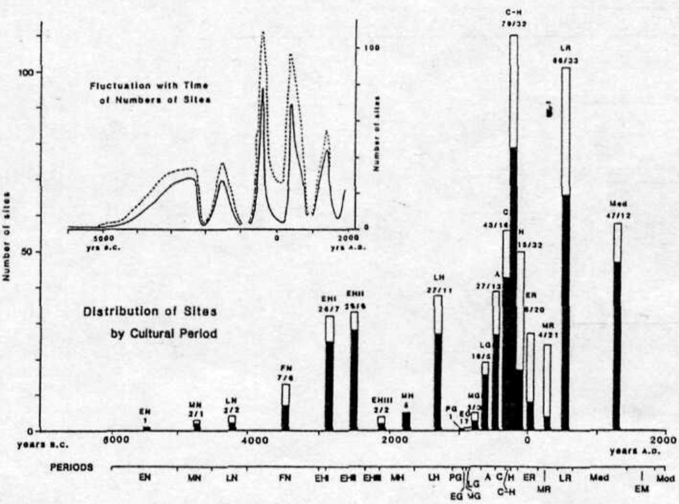


Fig. 16: Fluctuations in site numbers on the intensive survey of the S.W.Argolid, Greece (from [14] fig.4.4).

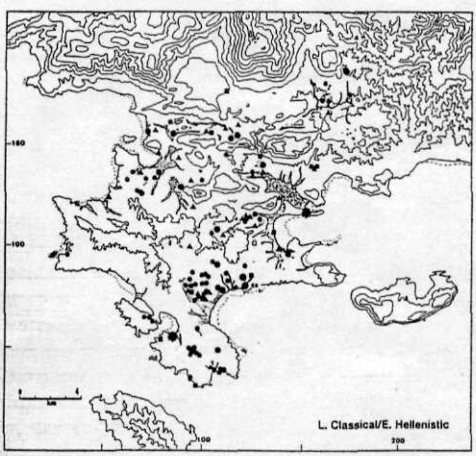


Fig. 17: Distribution of sites during the Late Classical-Early Hellenistic period on the S.W.Argolid Survey (from [14] fig.4.23).

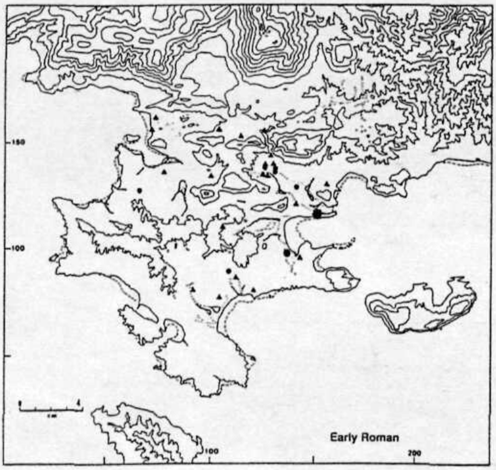


Fig. 18: Distribution of sites during the Early Roman period on the S.W.Argolid Survey (from [14] fig.4.25).

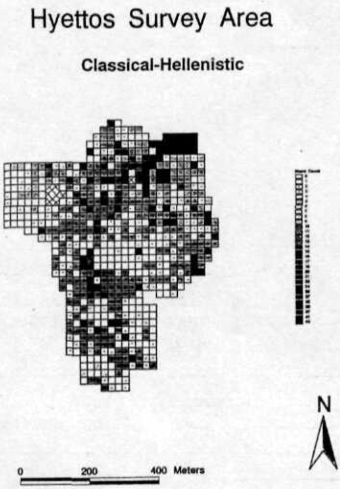


Fig. 19: Distribution of Classical-Early Hellenistic pottery across the surface of the city of Hyettos, Boeotia. The sample grid consists of over 600 units each 400 square metres in size (prepared by S.Fuller from the author's data).

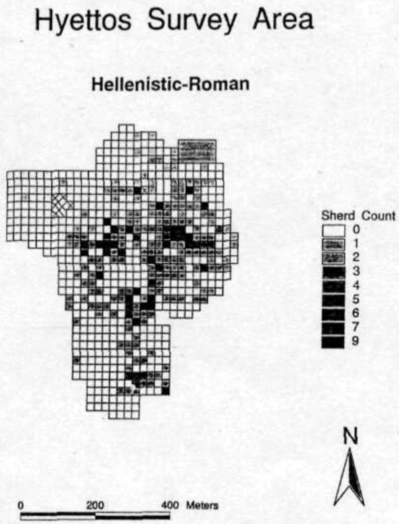


Fig. 20: Distribution of Late Hellenistic-Early Roman pottery across the surface of the city of Hyettos, Boeotia. A clear reduction both in the size of the occupied area and the intensity of activity seem indicated. (Prepared by S.Fuller from the author's data).

Further Interpretative Possibilities

In the late 1990's we are now in the situation in many regions of Southern Europe where it is possible, using regional surface survey, to compare and contrast the demographic curves of individual regions with each other, allowing an interregional perspective. Such a wider view is essential since we know that regions of pre-Industrial Europe did not exist in isolation, but were tied, in varying degrees, to political and economic, as well as demographic trends in other regions. Nonetheless, it seems clear that regions normally had strong internal development trends that interacted both positively and negatively with influences at the interregional level.

I recently undertook a preliminary comparison across the different provinces of Greece and the Aegean Islands of the timing of population and urban climax between 1000 BC and 700 AD [16]. Figure 21 shows the generalized results of this exercise. It proved possible to identify a limited number of models which could account for the differing growth trajectories of individual regions. Figure 22 shows the models which accounted for most of the variability in the data.

At the opposite end of the spatial scale, current research developments in surface survey are also focussing on variability, but this time of surface ceramic finds across each region. Thus Todd Whitelaw on the Kea Project [17] has examined the frequency of types of cooking, storage and tableware at Classical rural sites and compared them with a town site. On the Boeotia Project, Joanita Vroom [18] has been studying surface pottery from Medieval village sites and begun to relate the changing shapes to alterations in cooking and eating habits in High Medieval and early Post-Medieval Europe.

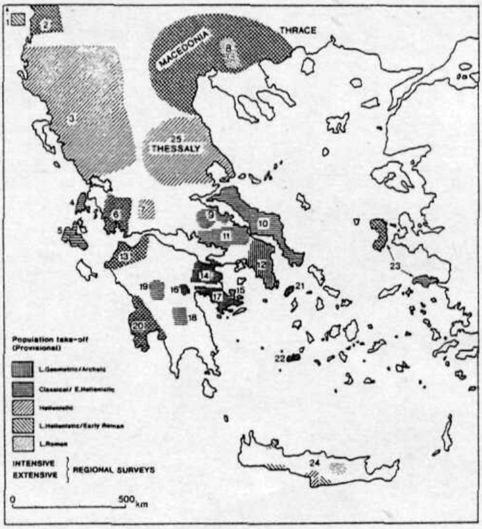


Fig. 21: The timing of demographic and urban takeoff in the different provinces of ancient Greece between Geometric and Late Roman times (from [16])

GIS and Virtual Reality Regions

With the rapid introduction of digitised maps and the use of Geographical Information Systems software to analyse and manipulate archaeological spatial data, the rich databases of settlement history that regional survey provide are being explored in dynamic and very novel ways. GIS allows a rapid calculation of problems that formerly involved long fieldwork, for example the relationship of a surface site to different land categories in its vicinity, the communication potential of a settlement location, the intervisibility of sites from each other. But via virtual reality software, we can take the digitised maps, add the discovered settlements, shrines and sanctuaries of any particular time in the past, plus our best reconstruction of land use and vegetation cover, and 'walk back into' a virtual reality survey landscape. Apart from the heuristic value of exploring the archaeological landscapes we have pieced together, as if we were ancient inhabitants, these new tools will prove of immense value in communicating the results of regional projects to the general public in the most accessible and enjoyable way.

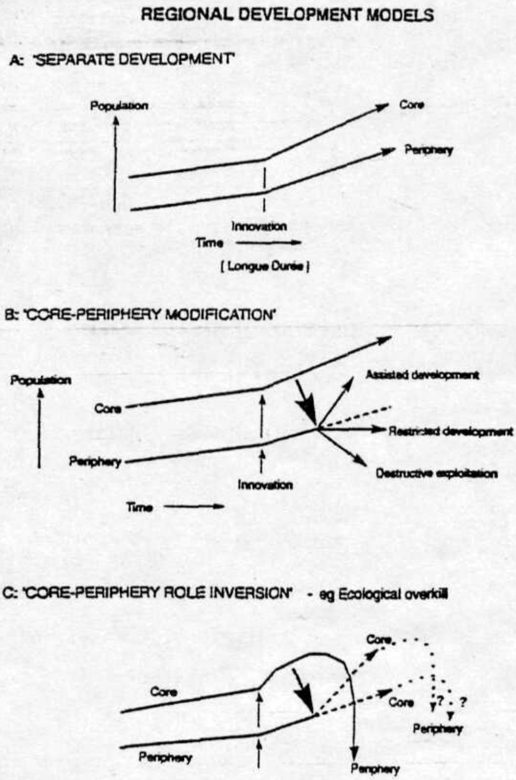


Fig. 22: Models for regional development in ancient and later prehistoric Greece. These models largely account for the variability in regional growth dynamics observable from current intensive and extensive survey data (from [16]).

Conclusion

Recalling my opening comments on the imaginative attempts of Classicizing painters to place us in past landscapes, current computer imaging has in some respects overtaken Poussin and Lorraine by allowing us to walk into and around Classical landscapes, whilst the rapid progress of field survey methodology itself has given us a far more realistic reconstruction of what those and other past landscapes actually consisted of.

References

1. H. G. Lolling, *Reisenotizen aus Griechenland 1876 und 1877* (Reimer Verlag: Berlin, 1989).

2. H. Lehmann, Geographische Zeitschrift 45, 212-228 (1939).

3. W. A. McDonald and G. R. Rapp (Eds.), *The Minnesota Messenia Expedition. Reconstructing a Bronze Age Regional Environment* (University of Minnesota: Minneapolis, 1972).

4. T. W. Potter, *The Changing Landscape of South Etruria* (Elek: London, 1979).

5. C. Renfrew and M. Wagstaff (Eds.), *An Island Polity. The Archaeology of Exploitation in Melos* (Cambridge University Press: Cambridge, 1982).

6. J. L. Bintliff and A. M. Snodgrass, Journal of Field Archaeology 12, 123-161 (1985).

7. J. L. Bintliff and A. M. Snodgrass, Antiquity 62, 57-71 (1988).

8. J. C. Chapman, J. L. Bintliff, V. L. Gaffney and B. Slapsak (Eds.), *Recent Developments in Yugoslav Archaeology* (British Archaeological Reports, International Series 431: Oxford, 1988).

9. B. Wells, C. Runnels, and E. Zangger, Opuscula Atheniensia 18(15), 207-238 (1990).

10. J. C. Carter (Ed.), *The Pantanello Necropolis 1982-1989. An Interim Report* (The University of Texas at Austin: Austin, 1990).

11. J. L. Bintliff, in J. L. Bintliff, & H. Hamerow (Eds.), *Europe Between Late Antiquity and the Middle Ages. Recent Archaeological and Historical Research in Western and Southern Europe*, 111-130. (Tempus Reparatum, BAR International Series 617: Oxford, 1995)..

12. T. J. Wilkinson, The Journal of Field Archaeology 16, 31-46 (1989).

13. J. L. Bintliff, B. Davies, C. Gaffney, A. Snodgrass, and A. Waters, in S. Bottema, G. Entjes-Nieborg, and W. V. Zeist (Eds.), *Man's Role in the Shaping of the Eastern Mediterranean Landscape*, (A.A.Balkema: Rotterdam, 1990).

14. M. H. Jameson, C. N. Runnels and T. H. van Andel (Eds.), *A Greek Countryside. The Southern Argolid from Prehistory to the Present Day* (Stanford University Press: Stanford, California, 1994).

15. M. H. Jameson, C. N. Runnels and T. H. van Andel (Eds.), *A Greek Countryside. The Southern Argolid from Prehistory to the Present Day* (Stanford University Press: Stanford, California, 1994).

16. J. L. Bintliff, Journal of Field Archaeology 24, forthcoming (1997).

17. T. Whitelaw, in R. Francovich and H. Patterson (Eds.), *Methodological Issues in Mediterranean Landscape Archaeology: Artefact Studies* (Oxford, in Press).

18. J. C. Vroom, Annual of the British School at Athens, forthcoming (1997).