

Landscape Change in Classical Greece: A Review

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Abstract: *Ever since Plato there has been learned speculation on the degree to which the Greek landscape has continuously been transformed by physical and anthropogenically-induced processes, with implications for the rise and fall of civilisations in the region. During the last thirty years a much more intensive series of earth-science-focussed investigations – notably in conjunction with regional archaeological settlement studies – has provided us with a firmer basis for understanding both the timing and the degree of substantial modifications to the Greek landscape during the Holocene era. This paper will review the current state of research as regards the Classical landscape of Greece within the wider context of the Holocene as a whole.*

INTRODUCTION

Firstly, I should state that I am an archaeologist with a central interest in past landscapes and the patterns of their human occupance, so that my review of the geoarchaeology of ancient Greece is as much a conversation with geomorphologists and other earth scientists from the side of archaeology, – looking for helpful commentary back, – as it is an attempt at an objective review of recent developments in our understanding of regional landscape evolution (for an earlier review see Bintliff, 1992).

Secondly, it is worth noting that Greece has been favoured with considerable scientific landscape research from the end of the last century, so that a commentary on progress in Greek geoarchaeology may be of interest to scholars working in other parts of the Mediterranean on similar problems.

Finally, although the focus of this volume is on Classical landscapes and their geoarchaeology, I believe at present that we can obtain a somewhat clearer view of the timing and causation of major geomorphic changes in Classical times, through setting that period into a longer-term perspective – that of the Greek Holocene. I shall for the same reason make cross-reference to other Mediterranean geoarchaeological case-studies that help us comprehend the Greek scene better.

KEYPOINTS OF OLDER RESEARCH

The pioneer in modern, Mediterranean Holocene geoarchaeology was Claudio Vita-Finzi, whose clas-

sic investigation of Mediterranean alluviation (Vita-Finzi, 1969) is now thirty years old but remains the discussion focus for many key issues. The daring general dynamic model proposed by Vita-Finzi (Fig. 1, from Bintliff, 1977a), reduced almost all alluvial and related major colluvial expanses in Mediterranean river systems to the products of two time-confined eras of increased aggradation. The Older Fill (Stage 1) represented massive slope wash and colluviation during the last glacial period, reflecting a very different 'periglacial' regime in the Mediterranean region to that of today. During the early to mid Holocene there was little aggradation in valleys, whilst the erosion of the Older Fill and smallscale soil erosion contributed to competent stream systems whose bedloads were primarily concentrated in coastal delta formation (Stage 2). From later Roman Imperial times to the Middle Ages, and locally beyond into the early Post-Medieval era, a renewed phase of generalized aggradation occurred throughout Mediterranean river systems – the Younger Fill (Stage 3), to be followed by a recent tendency for reduced alluviation and downcutting through the second fill series. This recent aggradation is attributed to a phase or phases of wetter and cooler climate in the Mediterranean, including the well-attested global downturn of climate known as the Little Ice Age (16th-18th centuries AD). The implication of this scheme was that under the 'normal' long-term regime of Mediterranean climate, despite a history of intense human settlement, erosion was surprisingly limited, with landscape modification occurring in two long-spaced episodes. We can usefully categorize this model one of 'Punctuated Equilibrium', setting it into the wider insights of Stephen Jay Gould's vision of the nature of change in earth systems (Eldredge and Gould, 1972; Bintliff [Ed.], 1999).

Attracted though scholars were by the simplicity and revolutionary thrust of Vita-Finzi's scheme (not least myself, in my PhD research into Greek landscape history [Bintliff, 1977b]), simply adding up the number of countries surveyed in Vita-Finzi's *The Mediterranean Valleys* brings out the problem of rapid fieldwork – there was a lack of detailed local sequences tied closely to equally high-resolution reconstructions of human occupance in the same localities. During

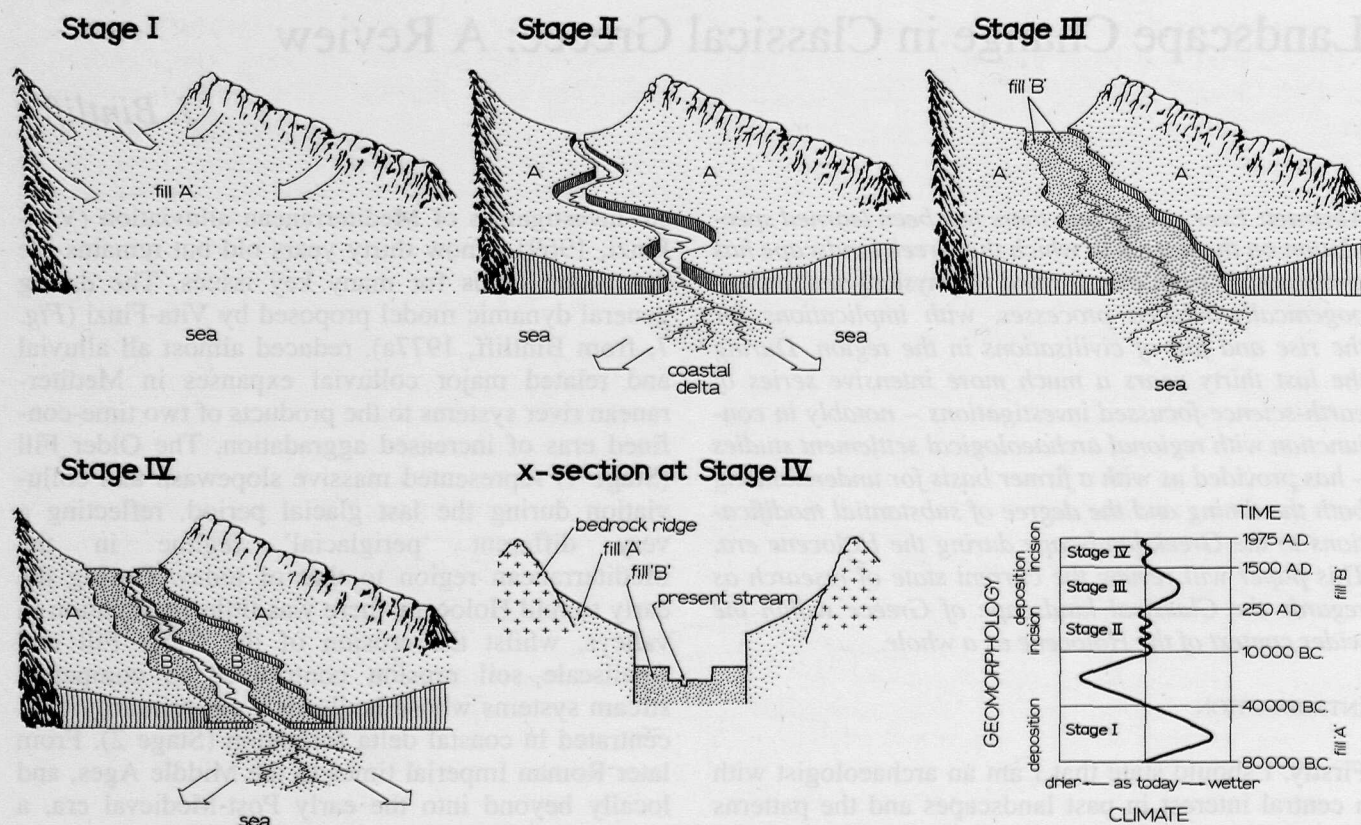


Fig.1: Vita-Finzi's model for Mediterranean alluvial history during the final Pleistocene and Holocene (from Bintliff, 1997a).

the 1970s and especially in the 1980s, however, a number of programmes specifically brought together interdisciplinary teams to form regional landscape history projects coordinated by archaeologists. The results were more focussed and more complex than the Vita-Finzi scheme had allowed for. To take one example, the work of the geomorphologist Donald Davidson for the Melos Project, directed by Colin Renfrew in the Cyclades (Renfrew and Wagstaff, 1982), showed clear evidence for slopewash accumulation on hillslopes, the result of a Bronze Age period of erosion on the island (which was also a time of rising human disturbance and settlement in the Cyclades).

Since the conference from which this volume originated took place in Ghent, it is a pleasure to record that another major regional project in Greece which advanced our detailed understanding at around the same time, was that of a Belgian archaeological project in Eastern Attica (Paepe et al. 1980). A series of widespread alluvial and palaeosol phases was identified. The V and W deposits represent gravels of the

last glacial period (comparable to Vita-Finzi's 'Older Fill'), over which lies a deep soil (the Marathon Soil) – indicating prolonged erosional stability during early and middle Holocene times. There follows an erosional phase with gravels (the Lower X), produced by slope failure and alluviation around the end of the Early Bronze Age (late 3rd millennium BC). A widespread cover of soil development (the Kifissos soil), marks stability into Classical Greek times. In late Classical or Early Hellenistic times there occurs a third alluvial deposition (the Lower X gravels) of limited duration. A subsequent phase of renewed erosion and alluviation occurs in Late Roman times (the Y deposits). After renewed soil development, slighter Early Modern erosion and deposition is represented by the Z gravels.

The geoarchaeologist responsible for the Attic series, Roland Paepe, noticed the similarities of two of these phases (the V-W and then Y Gravels), to the classic episodes of Vita-Finzi, and followed the latter's example in attributing the three additional erosional phases (Bronze Age, late Classical and Early Modern), to

climatic fluctuations deviating from the 'normal' Mediterranean pattern. Subsequent research by the same team in other parts of Attica has revealed an even more elaborate sequence (Paepe et al., 1987), but the published summary available to me is too brief to allow independent analysis.

Almost at the same time, however, an American team of geoarchaeologists assisting with an archaeological regional survey in the S.W. Argolid Peninsula in the

Peloponnese, was documenting a similar long-term erosion and deposition sequence (Pope and Van Andel, 1984; Jameson et al., 1994). What is rather remarkable about the Argolid sequence is that it is virtually identical to that from Eastern Attica, despite the fact that neither team was aware of the other's results (Fig. 2 shows the Argolid series with the Attic alluvia matched to their counterparts). There was an outstanding difference, nonetheless, in the evidence

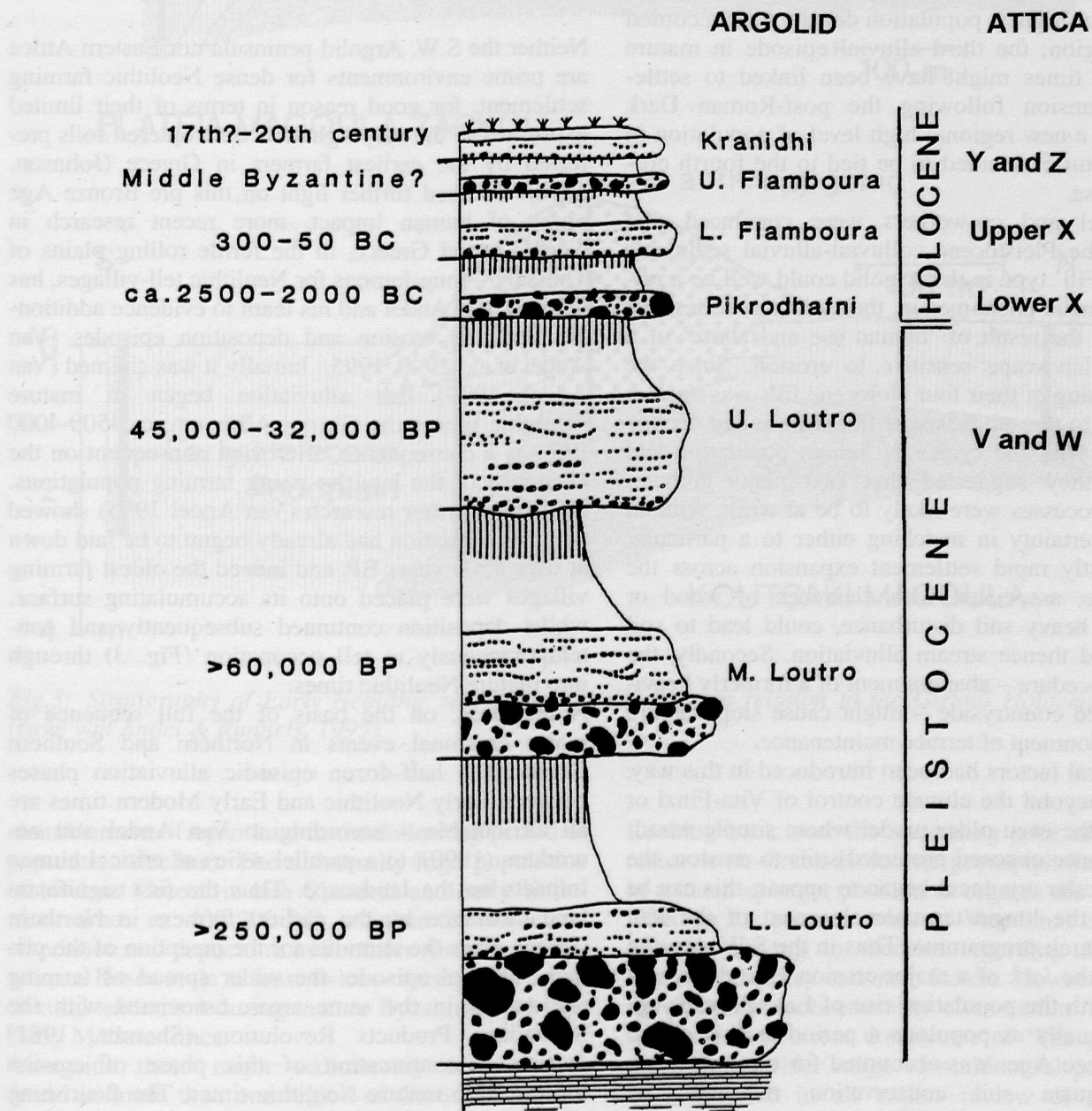


Fig.2: Comparison of the alluvial sedimentary sequence in the South-West Argolid and that from Eastern Attica (data from Van Andel, T., Runnels, C.N. & Pope, K.O., 1986, *Hesperia* 55: 103-128 and Paepe, 1980).

available for interpreting the sedimentary series – the Argolid team possessed the results of a pioneer intensive survey of human settlement dynamics for the area of geomorphological study, whilst the Attic study lacked such vital information. Comparing the peaks of human occupation with the last four episodes of erosion in the Argolid produced a notable association: thus a substantial spread of farming sites in the Early Bronze Age led into the first major alluviation phase, whilst the next erosion period in late-Classical to early-Hellenistic times could be linked to the era of highest population density ever recorded for the region; the third alluvial episode in mature Byzantine times might have been linked to settlement expansion following the post-Roman Dark Ages, and a new regional high level of population in recent centuries seemed to be tied to the fourth erosional phase.

Van Andel and co-workers were convinced that although the Pleistocene colluvial-alluvial sediments of 'Older Fill' type in the Argolid could well be a primarily climatic phenomenon, the Holocene series was essentially the result of 'human use and abuse' of a semi-arid landscape sensitive to erosion. Since the precise timing of their four Holocene fills was unclear in relation to the subphases of florescence and decline associated with the cycles of human population and land-use, they suggested that two major human-induced processes were likely to be at work, without claiming certainty in matching either to a particular event. Firstly rapid settlement expansion across the countryside, associated with clearance of wood or scrub and heavy soil disturbance, could lead to soil erosion and thence stream alluviation. Secondly, the reverse procedure – abandonment of a formerly heavily-populated countryside – might cause slope failure with abandonment of terrace maintenance.

Once several factors had been introduced in this way, however, beyond the climate control of Vita-Finzi or Paepe, or the even older model where simple woodland clearance exposed protected soils to erosion, the risk of circular argument began to appear; this can be seen with the longer-term development of the Van Andel research programme. Thus in the S.W. Argolid sequence, the *lack* of a major erosion episode to correspond with the population rise of Late Bronze Age times – equally as populous a period as that of the Early Bronze Age, was accounted for through inferring adequate soil conservation measures by Mycenaean farmers. The absence of erosion during the era of catastrophic depopulation in the post-Mycenaean Dark Ages was explained through rapid reafforestation of abandoned land. The Late Roman

highpoint in population was likewise lacking an erosion link – despite its more dramatic dimensions compared to the population rise of Byzantine times, where alluviation *was* recognized. These anomalies also underlined the less-than-secure dating of these fills – earlier published associations of the 'medieval' fill in the Argolid survey region were Late Roman in age (Bintliff, 1977b, pp.178-180, ignored in Van Andel's account).

RECENT RESEARCH

Neither the S.W. Argolid peninsula nor Eastern Attica are prime environments for dense Neolithic farming settlement, for good reason in terms of their limited exposures of the very light and well-watered soils preferred by the earliest farmers in Greece (Johnson, 1996). To shed further light on this pre-Bronze Age phase of human impact, more recent research in North-Central Greece, in the fertile rolling plains of Thessaly – long-famous for Neolithic tell-villages, has allowed Van Andel and his team to evidence additional, Neolithic erosion and deposition episodes (Van Andel et al., 1990, 1995). Initially it was claimed (Van Andel 1990) that alluviation began in mature Neolithic times (the Girtoni Alluvium, ca.4500-4000 BC), as a consequence of erosion consequent on the clearance of the land by rising farming populations. However, further research (Van Andel 1995) showed that this formation had already begun to be laid down at over 8500 years BP, and indeed the oldest farming villages were placed onto its accumulating surface, whilst deposition continued subsequently and contemporaneously to tell occupation (*Fig. 3*) through into mature Neolithic times.

Nonetheless, on the basis of the full sequence of major erosional events in Northern and Southern Greece, the half-dozen episodic alluviation phases between Early Neolithic and Early Modern times are all attributable – according to Van Andel and co-workers (1990), to a parallel series of critical human impacts on the landscape. Thus the first significant land clearance by the earliest farmers in Northern Greece gives the stimulus for the inception of the primary alluvial episode; the wider spread of farming settlements in the same areas, associated with the Secondary Products Revolution (Sherratt, 1981) ensures a continuation of this phase of erosion through into mature Neolithic times. The flourishing of rural communities in the Early Bronze Age of Southern Greece gives rise to the major alluvial episode towards the end of the 3rd millennium BC (either through more intensive clearance, or subsequent

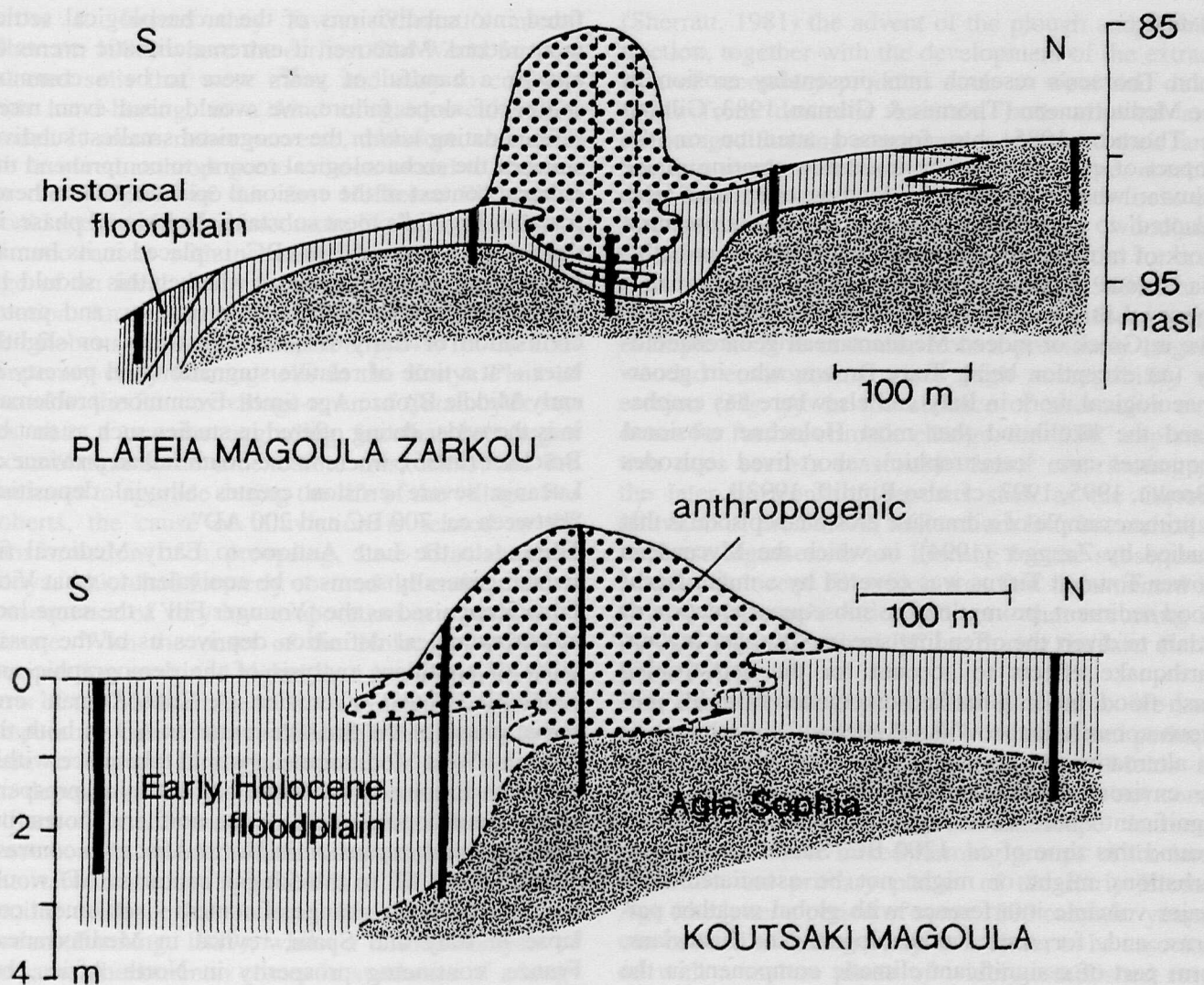


Fig.3: Stratigraphy of Early Neolithic tell villages in Thessaly in relation to the Girtoni Holocene alluvium (from van Andel & Runnels, 1995).

abandonment of open land in the following period of population decline). The universally-high population of lowland Greece in late Classical and early Hellenistic times, ca. 400-200 BC, is linked to well-attested erosion and deposition in Southern Greece, repeated on a lesser scale at least twice – during the revival of rural settlement during mature Byzantine and then Early Modern times.

Alongside these major sedimentary series, often found in more than one region of Greece, there are lesser or more localised, additional erosion episodes, such as the catastrophic Mycenaean or Late Bronze Age flood deposit documented by Zangger in the Argive Plain (Zangger, 1994).

Looking back over the increasing pace of published research on Greek Holocene geomorphology, we are in a much stronger position as regards the data, compared to the pioneer work of Vita-Finzi thirty years ago, in moving to theories regarding the relative importance of key causative factors. However, between the dogmatic monocausality of an earlier 'Vita-Finzi-ism' and the current dominance of 'Van Andel-ism' there lies a wider range of multicausal possibilities, as I outlined in an earlier review of the debate (Bintliff, 1992). I will now pass on to review some of the problems and questions one might raise with the current orthodoxy – which is that of the Van Andel position.

John Thornes's research into presentday erosion in the Mediterranean (Thornes & Gilman, 1983, Gilman & Thornes, 1985) has focussed attention on the impact of extreme climatic events on creating major alluvia; whether or not the land is open and 'pre-adapted' to erosion, his message is that the essential work of moving slope material into colluvia and alluvia is done by unusual natural – rather than human – agency. Little account has been taken of this perspective in Greek or indeed Mediterranean geoarchaeology (an exception being Tony Brown, who in geoarchaeological work in Italy and elsewhere has emphasized the likelihood that most Holocene erosional sequences are 'catastrophic', short-lived episodes [Brown, 1995, 1997; cf. also Bintliff, 1992]).

A prime example of a dramatic erosional episode is that studied by Zangger (1994), in which the Mycenaean Lower Town at Tiryns was covered by a major flash-flood sediment, prompting the subsequent erection of a dam to divert the offending stream. Zangger favours earthquake effects to account for the catastrophic flash-flood, but in a marked divergence from his previous commitment to 'Van Andelism', introduces as an alternative the case being made, or rather revived, by environmental scientists and climatologists, for significant but short-lived climatic fluctuations around this time of ca. 1200 BC. Such climatic perturbations might or might not be associated with major volcanic interference with global weather patterns, and, for some archaeologists and historians, form part of a significant climatic component in the contemporary decline of several East Mediterranean civilisations. On the other hand, we could read Thornes' work as more straightforwardly arguing for recurrent but non-linear extreme weather events as an expected feature of semi-arid climates, but which strike most effectively at already highly-sensitised landscapes. One could imagine two possible scenarios – one where high land-use opened up a semi-arid landscape to major erosion which did *not* occur, in the absence of an extreme rainfall event, and another where that extreme event (or series of events) *did* occur on the same kind of preadapted open surfaces.

If we bear these considerations in mind, then one of our problems in making further progress, despite the rise in physical data, is our general dearth of close-dating. We are often unclear, as with Van Andel's Argolid work, whether a particular alluvial fill coincides with major woodland or scrub clearance, the peak of established land-use, or following partial rural abandonment, since the alluvia are not precisely

fitted into subdivisions of the archaeological settlement record. Moreover, if extreme climatic events of one or a handful of years were to be a common source of slope failure, we would need even more refined dating *within* the recognised smallest subdivisions of the archaeological record, to comprehend the cultural context of the erosional episode. When therefore the Argolid's most substantial erosional phase, in the centuries around 2000 BC, is placed in its human context, we are still unclear whether this should be during the time of maximum prosperity and proto-civilisation of Early Bronze Age times, or slightly later – at a time of relative stagnation and poverty in early Middle Bronze Age times. Even more problematic is the wider dating offered in studies such as that by Brückner (1986), where in the South Italian province of Lucania severe erosion creates alluvial deposition "between ca. 700 BC and 200 AD".

Turning to the Late Antique to Early Medieval fill (which generally seems to be equivalent to what Vita-Finzi recognised as the 'Younger Fill'), the same lack of chronological definition deprives us of the possibility of confident analysis of the demographic and economic context of erosion. A 'Late Roman' erosional phase of the 3rd-4th centuries AD in both the East and West Mediterranean would take place within a Roman Empire of moderate but declining prosperity and rural populousness on the northern shores, but booming rural expansion in North Africa; in contrast, dating such a fill to the 5th-6th centuries AD would require a dramatic change of context – settlement collapse in Italy and Spain, revival in Mediterranean France, continuing prosperity in North Africa, but remarkable rural expansion through the East Mediterranean. When a recent study in the mountainous province of Epirus in North-West Greece (Woodward et al., 1994) identified just one significant Holocene alluvial phase, an Early Medieval at ca. 900 or 1100 AD, that slight difference in age corresponds to wildly contrasted historical contexts – from the deep recession of human activity at the end of the post-Roman Dark Ages to the vigorous revival associated with mature Byzantine civilisation.

CAUSES

The Early Holocene Fill

In Thessaly, the earliest Holocene facies of the so-called 'Niederterrasse' is the Gironi alluvium. The stratigraphic evidence as presented by Van Andel's team (1995) suggests that this is actively accumulating *before* the spread of the first tell farming settlements

across it. Indeed they favour Sherratt's model (Sherratt, 1980) where the earliest Old World farmers selected soils that were moist and easy to cultivate with hand-hoeing, in a kind of garden-cultivation model. It seems rather perverse, therefore, to stretch the favoured anthropogenic-erosion model to account for the inception of this first Holocene fill, and it would seem as likely, if not more likely, to postulate a climatic cause – with incoming farmers taking advantage of an ideal environment already in process of creation. An exactly parallel situation is described by Neil Roberts (Roberts, 1996; 1998, p.149) for the contemporary early farming tells in the Konya Plain of Anatolia: the famous village-town of Çatalhöyük settles onto a massive aggrading fan that had begun accumulation some time before this, whilst the fan continues to aggrade during the life of the village. For Roberts, the cause of alluviation is related to the transformation of a preceding, Late Glacial, Lake Konya, which had formerly covered the entire plain, a consequence of very low evaporation in a periglacial climate. With the onset of the Holocene, effective precipitation remained higher than presentday in most parts of the Mediterranean, but a dramatic increase in temperature caused the considerable drainage into the plain to convert through evaporation into subaerial fan deposition. On the largest of these fans the first settlers of Çatal found their ideal moist farming niche – not heavily wooded either, as a result of the high watertable and active aggradation.

Similar evidence has recently been published from Jordan (Banning, 1989), whilst a refined analysis of the same phenomenon comes in syntheses of a long-term programme of geoarchaeological investigations in Tunisia by Ballais (1992, 1995). The widespread Early Holocene wadi fill of Tunisia not only lacks archaeological association with any major human impact, but bears a clear relationship to abundant palaeoenvironmental evidence for a climate highly divergent from the semi-arid Mediterranean to arid Saharan regime found today; the most spectacular evidence for this Early Holocene moist phase emanates from the Sahara itself, with plentiful water supplies and game (cf. Roberts 1998, Ch.4).

The Middle Holocene Fill

In later Neolithic times in Thessaly a further stage of alluviation within the Niederterrasse is given an anthropogenic causation by Van Andel et al., again placed in the context of Andrew Sherratt's sequence for farming developments in the Old World. According to Sherratt's 'Secondary Products' Revolution

(Sherratt, 1981) the advent of the plough and animal traction, together with the development of the extraction of secondary products such as wool and dairy foods from domestic animals, both allowed and encouraged farming communities to extend their land use into much wider areas of the landscape, notably drier interfluvial zones away from the earlier focus on wet bottomlands. A process of major woodland clearance ought to result, with high potential for erosion, in line with John Thornes' view (1989) that a dramatic opening up of a vegetated landscape, for example to 70% or more, from a previously largely wooded environment, gives high susceptibility to erosion (Fig. 4). In the absence of alternative evidence for further climatic change, the '2PR' explanation does seem a reasonable factor contributing to the later horizons of deposits such as the Giritoni alluvium of the 5th-4th millennium BC, but a similar land-use argument is too limiting for the subsequent Middle Holocene fill which was first documented in Greece in Paepke's Attica project – that occurring in the late 3rd millennium BC i.e. during the later Early Bronze Age.

The Early Bronze Age erosion episode, as we saw also well-represented in the S.W. Argolid and perhaps to be correlated with colluviation on Melos in Davidson's study cited earlier, clearly does not come at the first phase of widespread landscape clearance in Greece – where mixed farming groups of the later Neolithic and primary phases of the Early Bronze Age (the latter a period of some 1500 calendar years), can be seen to lead the way. It is either to be associated with a mature phase of widely-established rural land-use, or subsequent to widespread abandonment of rural sites and depopulation at the end of the Early Bronze Age. For Van Andel's team, the favoured explanation is the latter, with erosion due to neglected terrace-walls releasing stored cultivated soil. This is problematic, since scrub colonisation even in Southern Greece is a rapid stabiliser of uncultivated land surfaces (Rackham, 1983); a more effective case would be to postulate a reduced human population burning the now uncultivated lands regularly to encourage plants for grazing, thus exposing soils to erosion – such a scenario can be observed following modern forest fires in Greece. On the other hand, the general construction of terrace-walls in Early Bronze Age Greece has yet to be attested, and the same goes for widespread late 3rd. or early 2nd. millennium pastoralism.

Although the anthropogenic explanation is still feasible, the confirmatory evidence is lacking. In contrast, we do have firm evidence that this particular time is

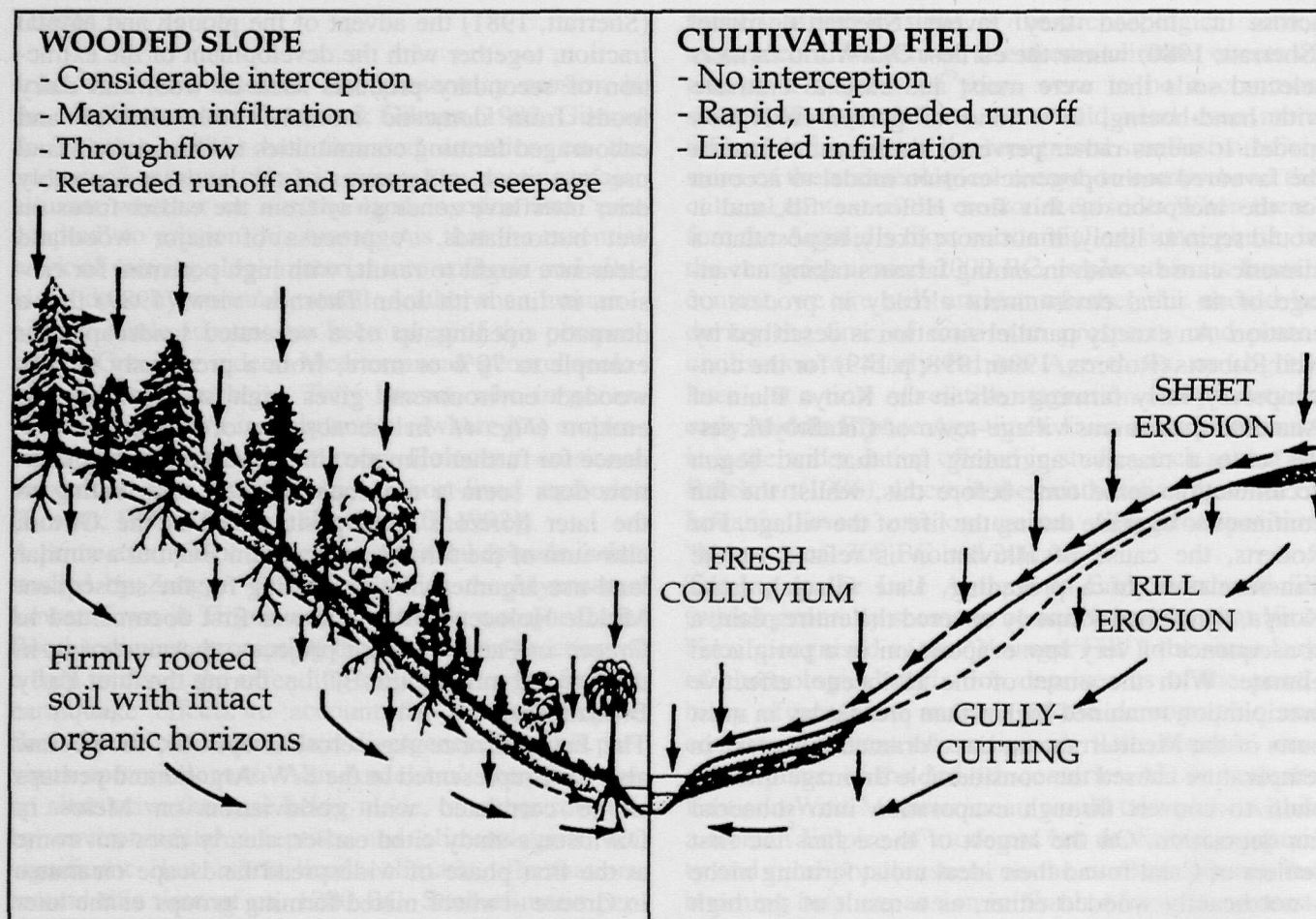


Fig.4: Model scenario for the inception of major erosion, colluviation and alluviation following massive woodland clearance (after Butzer, from Woodward, 1995).

associated elsewhere in the East Mediterranean with major climatic changes driving landscape transformation, and with the same kind of settlement dislocation noted in Southern Greece in the final centuries of the 3rd. millennium BC. In Israel, for example, Arlene Rosen (Rosen, 1995) has argued that the flourishing expansion of tells of the Early Bronze Age was based in part on fertile alluvial soils laid down in the later stages of a moister climate than present during the 5th-4th millennia BC. In the later 3rd millennium, during the transformation of this climate to the modern 'Mediterranean' semi-arid regime, an abrupt hyperarid episode caused a major erosional event, which swept away important areas of cultivation and contributed to a subsequent major disruption in the settlement system. In North Mesopotamia, the research team led by Harvey

Weiss have also identified a major climatic fluctuation at this same time from palaeoenvironmental data as a prime cause in the collapse of an elaborate tell system of the 3rd. millennium BC (Weiss et al, 1993). In the Maghreb, the general trend to climatic aridification in the 4th-3rd millennia BC intensifies from the late 3rd millennium BC (Ballais, 1992).

The Classical Greco-Roman Fills

Far more convincing a case can be made for direct human impact catalyzing erosion in the fills documented during Classical, Hellenistic and Roman Imperial times around the Mediterranean. Population levels during this long era at one time or another reached heights never before achieved. Yet in contrast to the traditional view voiced already by Plato (*Critias, III*) - whereby

erosion is a continuous process in heavily-utilized landscapes, the empirical evidence remains strongly punctuational, ie for most of the entire Greco-Roman era, ca. 700 BC to 630 AD, severe erosion and significant alluvial deposition are not taking place. Rather the picture provided by our more detailed view of Greece and the wider Mediterranean is better in keeping with Vita-Finzi's view, in that erosional episodes are short-lived compared to longer periods of relative landscape stability.

The last generation of intensive archaeological surveys has indeed provided a closer fit to this kind of scenario, by showing that there have been cyclical expansions and contractions in population across the landscape during this 1300 year era, a fact which could well have encouraged episodic destabilisation of the landscape in ways mentioned earlier. In the case of the South-West Argolid, where major erosion has been documented (Pope and Van Andel, 1984) for late Classical to earlier Hellenistic times, the chronology of deposition is still far from adequate to allow us to determine at which stage erosion was concentrated – during the Classical climax landuse, or subsequently, during Hellenistic depopulation. These authors prefer the limited evidence suggesting that slope failure resulted from rural depopulation, with failure of terrace walls the critical scenario. Yet then we are left without a reason for the rural depopulation in the first place, although our ignorance of other explanations need not rule out a primary political or economic explanation. And with uncertainties over dating, Van Andel is unable to dismiss an explanation in which climax land-use sparked erosion, which then caused rural depopulation.

Given the narrowly-culturalist determinism of Van Andel, it has to be rather liberating to introduce quite a different view of a related phenomenon elsewhere in the Greco-Roman Mediterranean. Let us turn once more to Ballais' synthesis of Tunisian erosional history (Ballais, 1991, 1992, 1995). A wide series of field studies has identified a major later Holocene terrace. Close chronological control demonstrates that although there was progressive agricultural intake during the later 1st millennium BC and early 1st millennium AD (in Carthaginian and then Roman times), from the coastlands into the Tunisian hinterland and ultimately the fringes of the Sahara, the fill is essentially synchronous and belongs to Roman Imperial times. By this stage we are dealing with a fully open landscape which has been highly sensitized to erosion by human impact. And yet instead of a corresponding cline of aggradation against time, we find synchronicity; for

Ballais, in agreement with Thornes' empirical and theoretical conclusions, the preadaptation nonetheless awaits a minor climatic shift, or perhaps a series of unusual storm events, to launch the aggradational phase.

Erosion and Deposition in Medieval to Modern Times

Surprisingly, the scale of deposition in post-Roman times in Greece and around the Mediterranean is usually less significant than in the 3rd millennium BC and the Classical era – and that despite unparalleled mechanical aids to landscape disruption. It is surely important to note however, that there are many regions of the Mediterranean where rural populations have not reached earlier historic highpoints of Classical Greek or Early Roman Imperial times. Thus in large areas of Greece the available documentary sources and the evidence of intensive surface survey suggest levels of population in the late Classical period well above any previously or subsequently.

By and large the relationship between fill deposits of the post-Roman period and historic or archaeological sequences is poorly-known, with rather sweeping generalisations about Byzantine economic recovery in the final centuries of the 1st millennium AD, or the depredations of the Ottoman Turks and Venetians, standing in the place of thorough studies of small districts from the viewpoint of an integrated settlement and land use history combined with pedological and alluvial histories. Even if the now-evidenced continuation of cycles of population rise and fall throughout this long era gives reasonable cause to suggest that erosion may have been one result of the more dramatic ups and downs of rural settlement, it is also surely subjective bias to rule out any role for contributory influence from climatic fluctuations – either secular changes or unpredictable extreme storm events. Moreover, whereas we lack firm evidence for significant secular climatic changes during the long Greco-Roman era, leading one to suppose that any major impact on erosion would have to occur through the kind of catastrophic storms discussed by John Thornes, we do in contrast know with considerable confidence that European – and at times global – climate diverged considerably from recent norms for long periods in both Medieval and Post-Medieval times.

Fig. 5 (from Roberts 1998, fig.7.1) brings out the striking climatic changes associated with the peak of the High Medieval Warm Era, the subsequent decline of the 14th century AD, a short recovery in the later

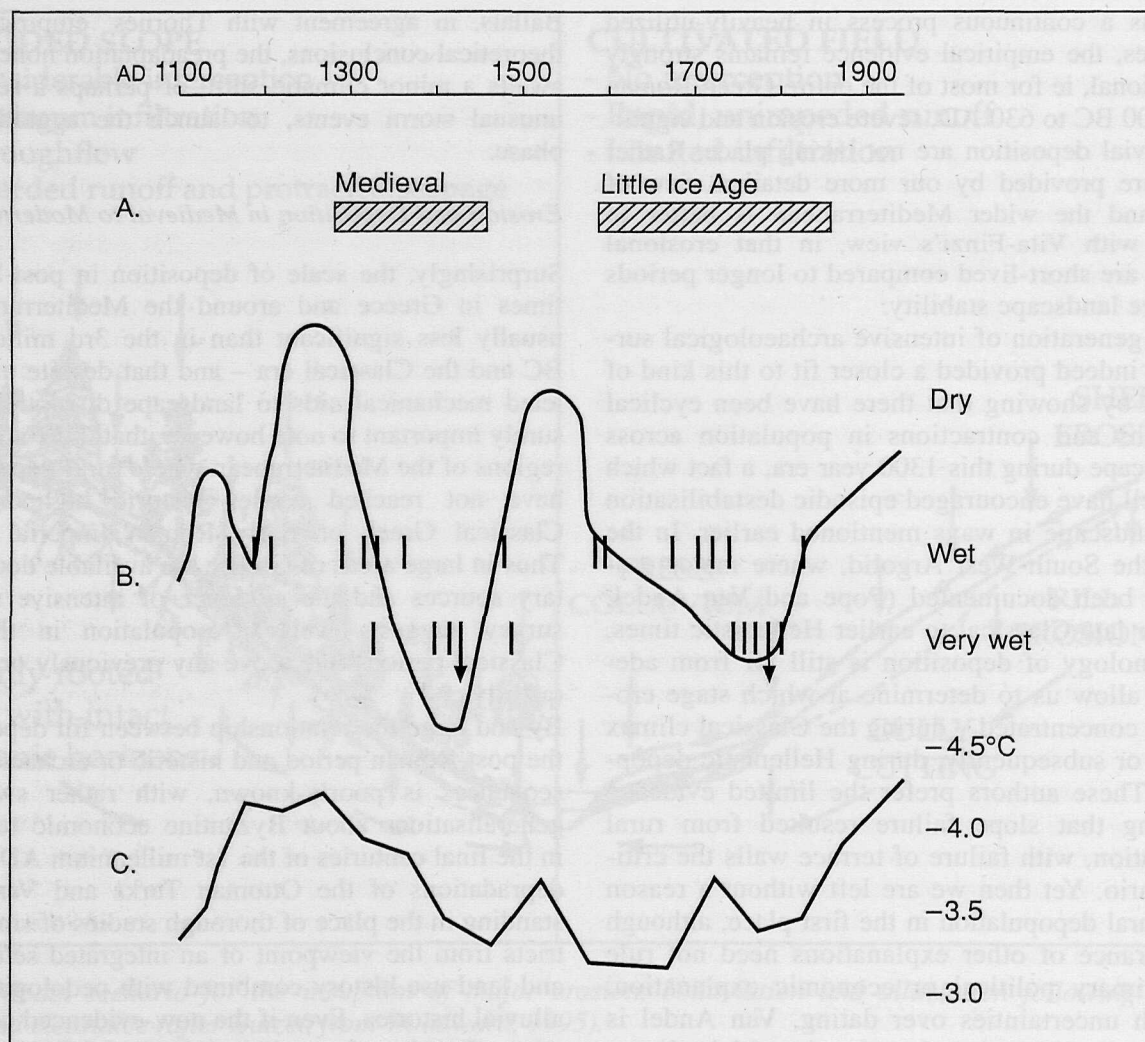


Fig.5: European climatic records over the last nine centuries. A = Alpine glacier advances; B = surface wetness curve, Bolton Fell peat bog; C = reconstructed winter temperatures for southern England (from Roberts, 1998, Fig.7.1).

15th and 16th centuries, then the Little Ice Age decline of the 17th-18th centuries AD. Contemporary accounts in Greece and elsewhere are eloquent for the Little Ice Age ubiquity of flooding, disease-ridden areas of poor drainage, and other factors which seem to have promoted rural poverty and underutilisation of land, although the economic and political decline of the Ottoman Empire was as much a cause of depopulation and rural disruption.

BEYOND VITA-FINZI-ISM AND VAN ANDEL-ISM: AN INTERACTIVE MODEL?

Instead of having to decide on climate *or* anthropogenic causation as monocausal alternatives, it

would perhaps be wiser to investigate the many ways in which natural and human impact factors interact to encourage or inhibit erosion and alluviation in Greece and the Mediterranean. This is certainly the more subtle approach adopted by Ballais in the Maghreb. Neil Roberts likewise prefers to deploy the concept of 'geological opportunism' in his excellent review of Mediterranean ecological history (Roberts 1998, p.150). Thus the selection by pioneer Neolithic farmers in the Near East and mainland Greece of actively-aggrading fans to settle on and cultivate, was a natural reaction from the point of view of their technological limitations and preferred 'horticultural' mode of cultivation. In the same way, when one reviews the debate about the

expansion during the Middle Holocene of evergreen Mediterranean woodland in the circum-Mediterranean Lowlands (Macklin, Lewin & Woodward, 1995; Roberts 1998, Chs.4 & 6), it is probably more profitable to see a mutual feedback between the recognized shift towards the modern semi-arid climate of this region, taking place from around 6000 BP onwards, and the contemporary expanding mixed farming colonisation of the same landscapes – where human clearance and both deliberate and accidental fires would favour the pyrophytic character of many major evergreen species.

In the same mode of thinking, we have raised the question as to whether many, or perhaps most, of the significant erosion and deposition episodes in the Middle to Late Holocene in Greece and the wider Mediterranean zone, reflect a prolonged 'window of opportunity' – when a high level of humanly-cleared landsurface lay preadapted for the unpredictable onset of a minor climatic fluctuation, or even a limited succession of freak weather events initiating serious slope failure. In this respect John Thornes' practically-orientated researches on erosional processes have served to remind us, that normally both gradual soil-creep and even more dramatic slopewash often accumulate for very variable periods in colluvial or intermediate drainage sedimentation, before being released into the bedload of a major stream. Perhaps these more subtle scenarios make sense of Ballais' North African alluvia: here the Early Roman fill is some five times the rate of accumulation of preceding Early-Middle Holocene fills in the region, yet whereas the associated human impact is progressive over time across the landscape, the timing of deposition in major valleys is considered to be synchronous.

As we have seen, such important feedback relations between the natural and human behavioural world may well have occurred in other times of significant transformation in the settled landscape. The strongly-evidenced expansion of communities in the Copper to Early Bronze Ages of the 4th-3rd millennia BC all around the Mediterranean are reasonably connected with the impact of plough traction and the Secondary Products' Revolution, but also coincide with the climatic shift from a moister Early to Mid Holocene climate to the classic Late Holocene 'Mediterranean' form of climate. The lasting effects of massive aridification in the Sahara form only the most undeniable consequences of this change, but accumulating evidence elsewhere makes it likely that the properties of soils and the growing seasons of plants cannot have remained unaffected. Investigating the interaction of these parallel phenomena will therefore be a task worth

pursuing, and Arlene Rosen's case-study across this transition clearly points the way to a more rounded nature-culture kind of geoarchaeology appropriate to such a study.

Even within the Late Holocene, secular cycles of climatic change have been well-documented, and some short-lived events argued to have had widespread effects. The present debate concerning a brief but catastrophic climatic perturbation around 2300-2200 BC, associated with major settlement dislocation over wide areas of the Near East and Greece, reminds us that a rapprochement is urgently needed to bridge the lack of communication between ardent human impact determinists such as van Andel and those equally confident in natural disaster scenarios. In this precise connection I would like to draw attention to the excellent article by Tony Wilkinson (1994) on the economics of Bronze Age settlements in North Mesopotamia, where he made a persuasive case for identifying a high-risk strategy pursued in the establishment of central-place networks across that region. Whether or not a Weiss-like natural catastrophe struck and wiped out crops, Wilkinson argued, is less important than the near prediction that in a semi-arid climate with a naturally highly-variable climate, overpopulation and over-dependency of settlement to settlement provided a scenario of risk waiting for crop failure – which would have occurred sooner or later even on the recorded climatic variability of the region.

WHAT IS NATURAL?

When we are asked to study a diagram such as that of Dedkov and Mozzherin, displaying the relative importance of natural and human contributions to the suspended sediment yield of mountain river basins in different climatic regions (*Fig. 6*, reproduced in Woodward, 1995), a conclusion that "around 75% of the sediment yield of Mediterranean headwater basins may be attributed to human activity" (Woodward, 1995, p.367) is not actually proven by the relevant data. This is all the more important to clarify, since Mediterranean yields are second only to glacial environments in this global comparison. What one needs to begin with, is a clear understanding of both the settlement and land-use history of each eco-zone, and, just as importantly, its natural erosion susceptibility. Since Mediterranean uplands have witnessed extensive human farming and pastoral settlement for some 6000 years, coincident as noted earlier, with the inception of the traditional 'Mediterranean' semi-arid climate regime in the region, the necessary control that science would require for a 'natural' level of erosion

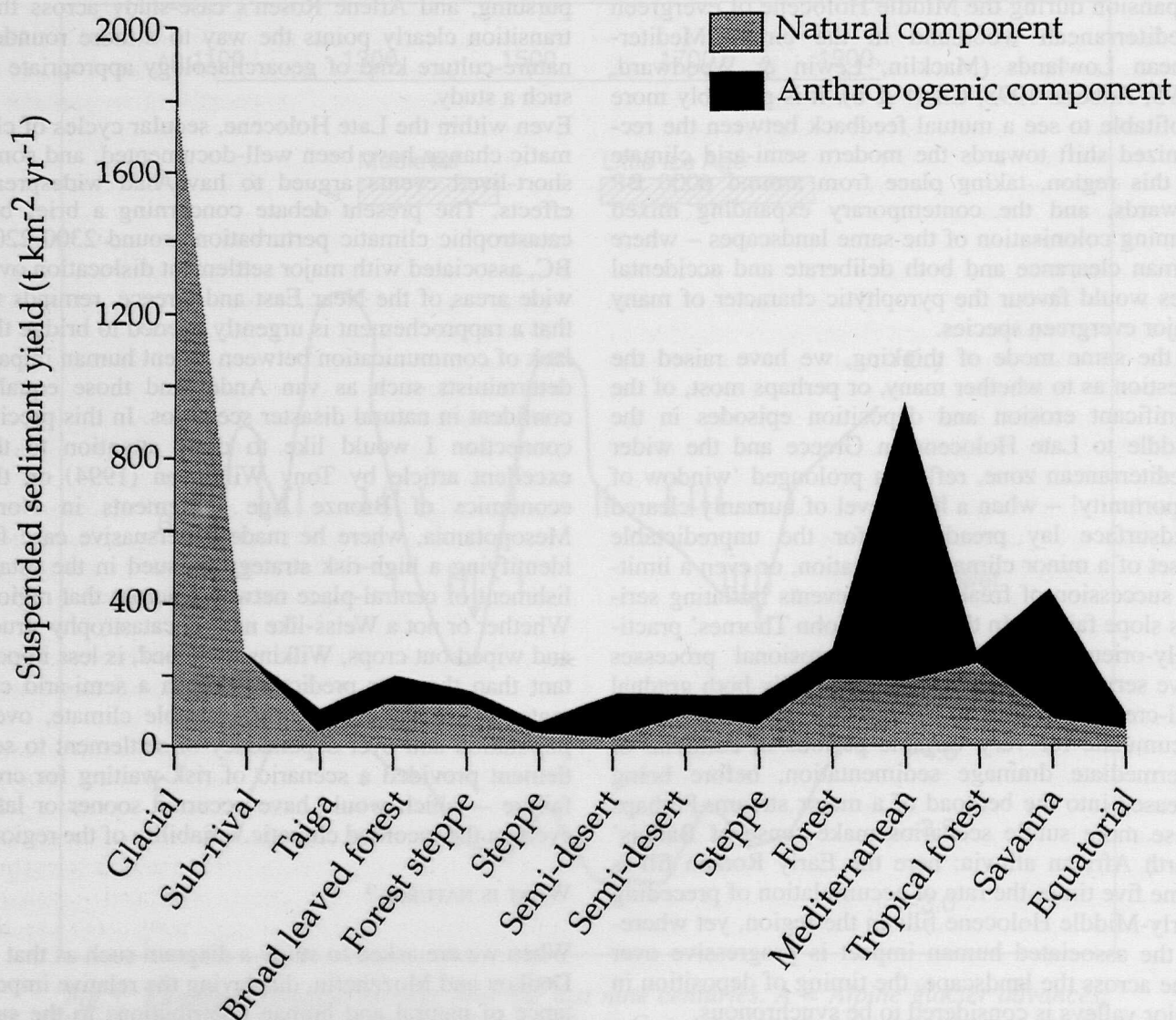


Fig.6: Relationship between natural and human contributions to the suspended sediment yield of mountain river basins in different climatic regions (after Dedkov & Mozzherin, from Woodward, 1995).

to contrast with the Middle to Late Holocene is absent. What for example would a 'natural' Interglacial landscape cycle look like *without* major human activity? Macklin and Passmore (1995) have tantalisingly cited a phase of Interglacial river fill from Spain believed to have resulted from an interstadial of wetter and cooler climate – one is reminded of the Little ice Age in Late Holocene times.

So in the first place, before assuming that the high erosion of Mediterranean lands is merely due to human impact, we should look more closely at levels of erosion in earlier Interglacials. Behind this question is another problem with such a diagram – differential sus-

ceptibility. The chart basically shows the association of human presence with high erosion, and one may note that the only ecozone with a comparably high 'anthropogenic component' is the savanna. How are we to read this association? Is it a higher density of people, or an unparalleled rate of landscape abuse, – or much more likely – a unique correlation between dense early agro-pastoral settlement and a remarkable natural susceptibility to erosion following either anthropogenic or natural vegetation removal? Students of the physical landscape in the Mediterranean are always struck by the phenomenal scale of Pleistocene colluvia and alluvia that take up a major part of Mediter-

anean valley systems (of Vita-Finzi's 'Older Fill' type); the great antiquity of these deposits and their geomorphic characteristics make it clear that these reflect extraordinary rates of naturally-induced erosion and deposition. Once human settlers have opened up the Holocene woodland cover, and this seems to become pronounced around the time that the Mediterranean climate settles in (with its variable and erosion-friendly character), is the region likely to suffer very high degradation rates, even if human land use practices were effectively no different from those in use for example in Temperate Woodland ecozones? The steep river catchments of most Mediterranean rivers due to their limited watershed distances from the Sea (Macklin, Lewin & Woodward, 1995, fig. 1), the naturally-high bedload supply in Alpine Mediterranean rivers, the extreme sensitivity of the increasingly more-arid east and south Mediterranean lands to minor climatic perturbations, and an exceptionally plentiful supply of readily-erodable geology put in place by the Alpine orogeny (Woodward, 1995), all provide ideal forces, ready to sweep into action, when either periglacial open environments or humanly-cleared environments reach major proportions. This pre-adaptation scenario seems to me to make far more sense than the unsustainable view implied earlier – that Mediterranean peoples have been more environmentally-careless and reached greater overpopulation than the peoples in any other ecozone of the world.

EFFECTS OF MAJOR EPISODES OF EROSION

Here I want to look at the scale of deposition over time and the kind of relationship between process and chronology that seems to dominate the Mediterranean landscape. Vita-Finzi's work remains the focus of discussion not so much for the over-precise dating and limited number of alluvial fills – both of which have had to be relaxed to allow of a wider range of deposits often not synchronous over the Mediterranean, but more for his invaluable insight (Bintliff, 1992) that the significant, largescale disruptions of the landscape preserved as alluvia and colluvia were discontinuous and temporally limited in time; most of the time major erosion was *not* occurring. This 'punctuated-equilibrium' model remains very convincing despite the wealth of greater detail now available to us from recent landscape studies, not least in Greece. It encourages a more dramatic view of landscape transformation, whether humanly-caused or linked to extreme climatic events operating in pre-adapted landscapes. It also has clear implications for societies

experiencing the effects, but additionally, it should be seen as posing interesting questions about 'normal' landscape processes in the Mediterranean – where for most of the time and contrary to popular and much scientific opinion – erosion cannot be considered as a constant threat.

One obvious example will illustrate the value of considering time and process: over large parts of the Mediterranean lowlands the surface deposits are composed of massive alluvial-colluvial fans and piedmont deposits of late Pliocene, Pleistocene and earliest Holocene age. The most recent facies can usually be dated to the last few glacial periods. The high energy and vast extent of these sediments can be read as the product of water regimes for which there is no parallel in the Mediterranean climate and river regime today – with the exception of the mountain perimeters (Macklin, Lewin & Woodward, 1995). Holocene rivers and streams operate with a vastly-reduced flow and lateral range, usually incised into these great fans. Although subject to some surface erosion, effectively large expanses of such 'Older Fill' type of deposit are *inactive* by the mature Holocene, a relict inheritance yet one with a strong influence on human settlement and land-use.

Another example which provides food for thought is that of Mediterranean 'Badlands'. Seemingly prima facie evidence for high contemporary erosion resulting from human abuse of the landscape, these hilly zones of the Mediterranean intermediate elevation terrain with their bare to poorly-vegetated slopes, are in fact – like the 'Older Fill' piedmont deposits – the product of a much longer-term process (Roberts 1998, p.189ff; Macklin, Lewin & Woodward, 1995). The Alpine mountain-building phase of Mediterranean geological history elevated vast areas of molasse sediments (submarine detritus from upland erosion accumulated in the proto-Mediterranean), at the same time erecting great mountain chains of denser limestone which rapidly eroded into additional intermontane detritus accumulations – flysch sediments. Thus over very large areas of the Mediterranean landscape, soft, easily erodable sediments were piled into heaps around the feet of young crystalline massifs. Regardless of human impact these sediments are prone to slippage and unstable vegetation cover. In many cases such sediments continue to be uplifted or otherwise displaced by neotectonics linked to the unstable plate history of the region, further encouraging slope instability. If one is struck by the characteristic and distinctive appearance of these discrete zones of 'Badland' sediments, it is therefore more to do with natural than anthropogenic processes. John Thornes in Spain has

shown how landscapes of this specific type had already developed their modern appearance before major human impact during the Holocene (Gilman and Thornes, 1985), whilst also in Spain, Jose Peña and colleagues have documented cyclical phases of slope stability and rejuvenation which do not relate in any direct way to waves of human land occupation (Mozota et al., 1986; Sancho et al., 1988). Similar work has been carried out on the Badlands of Italy and Greece. It seems from accumulated research, that such Badlands tend to settle into a punctuated-equilibrium mode, with long periods of slope stability and scrub cover associated with gentle soil creep adequate to hinder woodland development, interrupted at infrequent intervals by major slope renewals as a result of extreme storms or natural-human induced scrub fires. The agricultural potential of these zones is generally limited, so anthropogenic impact at most would mimic natural factors in initiating rejuvenation or increased erosion phases (through overgrazing and fire).

COASTAL DELTAS

We are accustomed to the almost shocking extension of coastal deltas in the Greco-Roman Mediterranean, with famous cities left landlocked or having to displace their ports on more than one occasion to retain links to the sea (*Fig. 7*: coastal regression for the major West Anatolian ancient cities of Ephesos and Miletos, after Eisma, 1978; cf. also the remarkable progression of the West Macedonian Plain in Northern Greece - Bintliff, 1976). It has been natural to blame human impact as the sole reason for these high rates of deltaic and estuarine sedimentation, which the plentiful historic sources for Classical Greek, Hellenistic and Roman Imperial times allow us to reconstruct in this way. Unparalleled density of human settlement and land clearance is assumed to be the single cause of massive rises in sediment supply. In fact, merely pondering on the far more variable rates of coastal change which the same studies demonstrate for later prehistory and the Medieval to Modern eras (cf. *Fig. 7* again) - when there are not insignificant cycles of clearance and afforestation at work, reminds us that the larger Mediterranean rivers have constantly throughout the Holocene brought considerable sediment loads to coastal baselevels (or lakes). What creates a strongly 'visible' estuarine progression is a scenario where subaerial deltas take over from submarine deposition at the coast, and it can be shown that the most striking alterations to Mediterranean coastlines during the Holocene occurred as a result of critical

points in the eustatic sealevel curve. Firstly around the Climatic Optimum of around 4500 bc sealevels reached unparalleled highpoints, with coastal retreat and marine penetration deep into modern coastal plains. Preceding estuarine and deltaic deposits were insufficient in depth to match parallel sea rise and hence formed submarine sediments; given the steep profile of the Final Pleistocene deposits on which Holocene estuarine deposits were laid down (graded towards a Mediterranean sealevel up to 130m below present), a considerable thickness of coastal sediment was nonetheless commonly achieved but for little subaerial effect (*Fig. 8*: A core-based section through the Plain of Troy sedimentary sequence, N.W. Turkey, after Kraft et al., 1980). By the first millennium BC eustatic rise had slowed down or ceased, henceforth remaining within a few metres globally of current level over the following 3000 years. Despite evidence for minor eustatic fluctuations, the general scenario now allowed estuarine deposition to vie for coastal space, and in some eras increases in river sedimentation and/or minor negative fluctuations or standstills in sealevel were quite sufficient to stimulate the 'emergence' of the estuarine deposition zone to subaerial visibility as a rapidly prograding delta. The very noticeable deltaic growth of Greco-Roman times is probably to be associated with increasing evidence for such a minor eustatic fall during this era, followed by a post-Classical eustatic rise of up to 2 metres by the presentday, documented in many parts of the Mediterranean. Otherwise it is difficult to account for the fact that many major plains show little or not major progradation in Medieval to Modern times, despite manifest historical and archaeological evidence for renewed periods of high population and land clearance. This is not to remove the likelihood that many regions of the Mediterranean hinterland witnessed high rates of erosion in Greco-Roman times, encouraging increased bedloads being brought down to coastal sedimentation zones. This in itself would certainly have provided a stronger possibility for the coastal extension of subaerial deltas. Yet the dramatic rate of progression just at a time when our historic records are very full, between 500 BC and 500 AD, has led to an overemphasis on monocausal anthropogenic explanation and all-but ignored the equally-important eustatic factor. Moreover, the thin surface coating of late Holocene subaerial deltaic sediments has encouraged a natural exaggeration of bedload rate changes, blinding us to the much thicker accumulations of early and middle Holocene deltaic deposition, which were submerged by fast-rate sealevel rise.

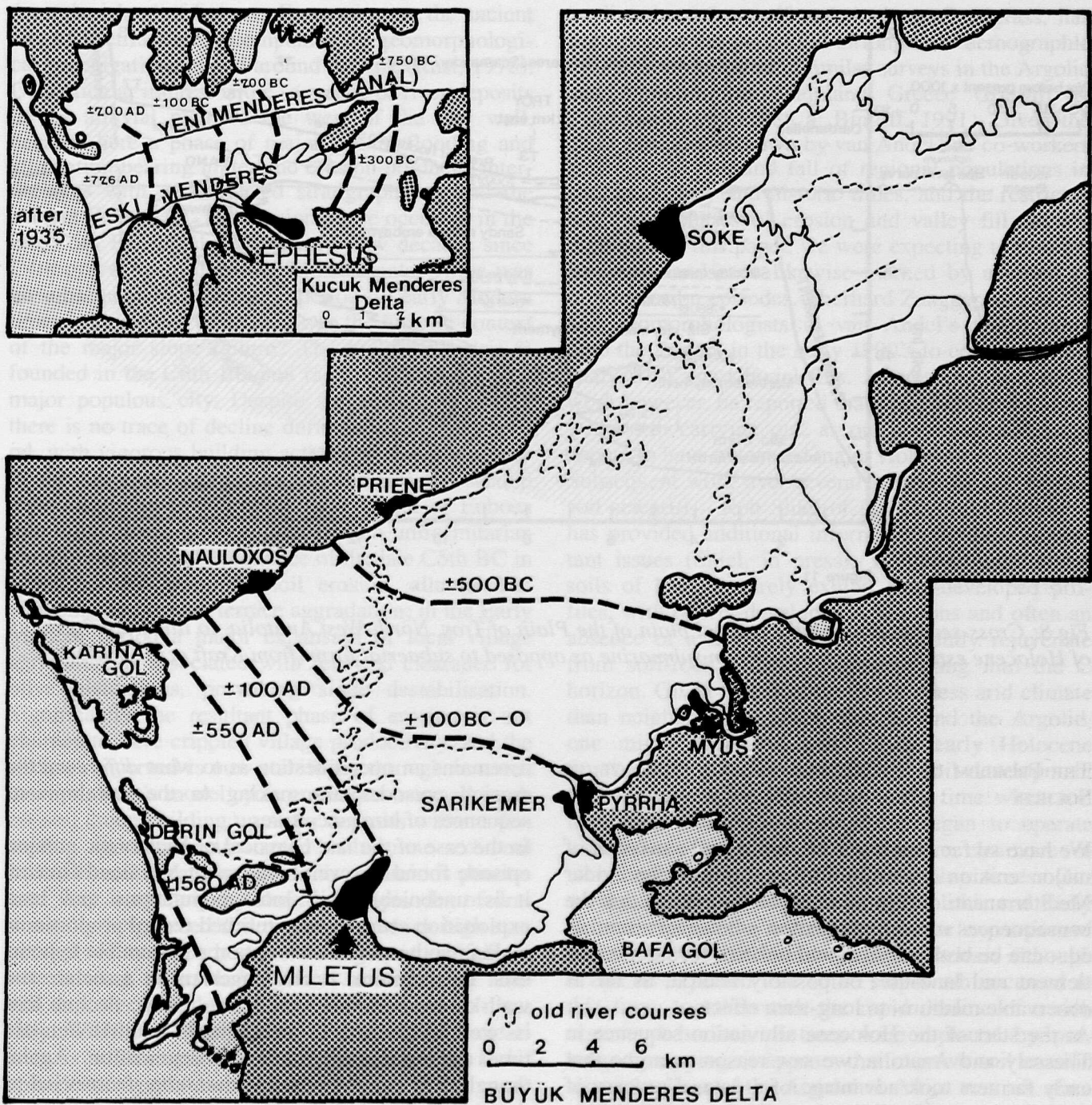


Fig.7: The advance of coastal plains in Western Anatolia since Antiquity, in relation to the ancient port-cities of Ephesos and Miletus (from Eisma, 1978).

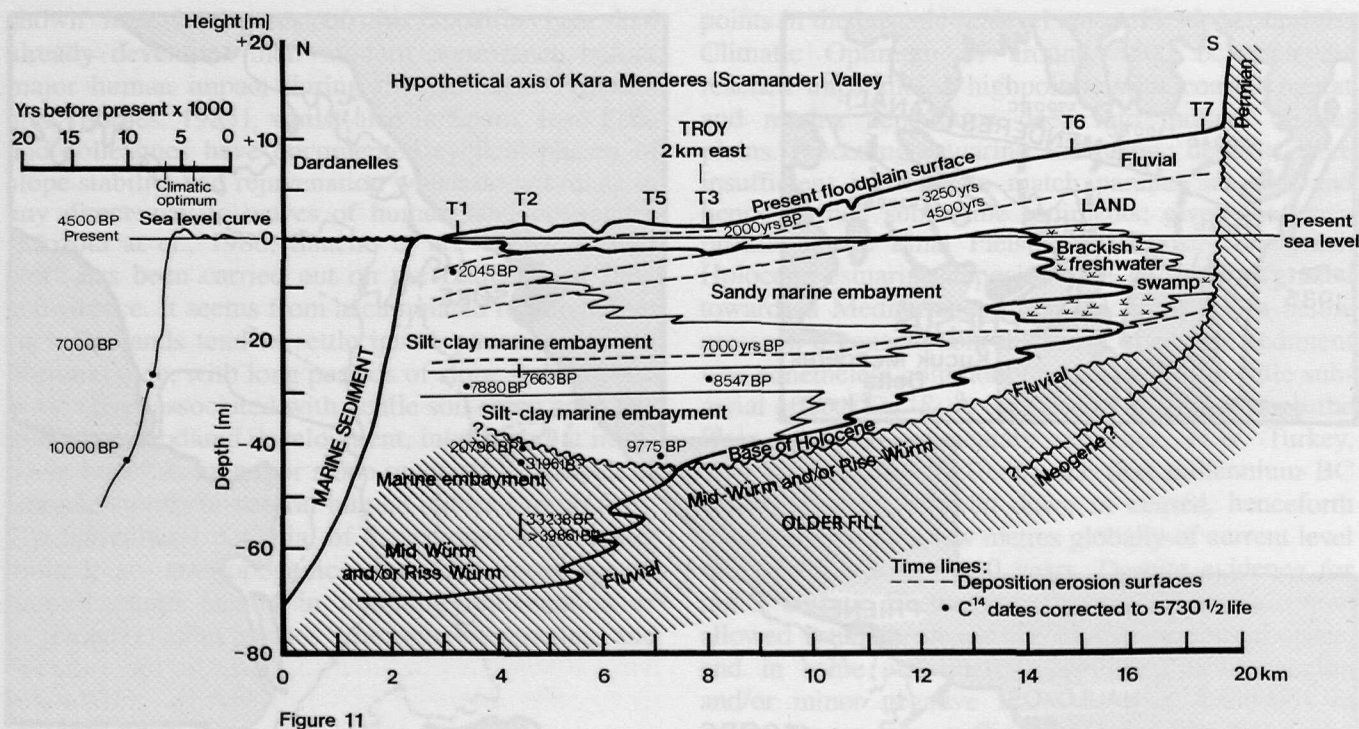


Figure 11

Fig.8: Cross-section through the coastal plain of the Plain of Troy, North-West Anatolia, to illustrate the depth of Holocene estuarine sedimentation in submarine as opposed to subaerial form (from Kraft et al., 1980).

THE PROBLEM OF TIMING AND EROSION'S IMPACT ON SOCIETY

We have so far examined the timing and causation of major erosion episodes in Greece and the wider Mediterranean. It also needs to be underlined that the consequences of such alluviation – however stimulated – can be both negative and positive for human settlement and land-use, or possibly neutral, as far as observable medium- to long-term effects.

At the start of the Holocene alluviation sequence in Thessaly and Anatolia, we saw reason to argue that early farmers took advantage of a natural process of sedimentation to establish long-lived and flourishing tell communities. In the late Early Bronze Age of Mainland Greece, a dramatic erosion horizon either contributed significantly to the downfall of a 'high culture', or merely marks the latter's collapse for other reasons – in which case its effect is to delay societal recovery for some hundreds of years. Since similar cycles of cultural florescence and decay punctuate the entire time-range of prehistoric and historic settlement in Greece, with only a few cycles being associated with such environmental transformations,

it remains an open question as to what *difference* the erosion episodes are making to the development sequences of human cultures.

In the case of the late Classical or Hellenistic erosion episode found in several regions of Mainland Greece, it is undeniable that local populations and land exploitation seem to have reached record proportions, making anthropogenic causation a reasonable hypothesis. Furthermore, it challenges us to associate the well-known economic and demographic decline that is well evidenced in subsequent Late Hellenistic times with such environmental degradation. Again, though, it is *equally* possible that other factors led to depopulation and land neglect, prompting erosion out of abandoned terraces. It is even possible, that such erosion episodes were not as critical to productivity as has been claimed? These issues are, as we can see, rather important to any proper understanding of Classical Greece, and it is therefore frustrating that the timing and exact economic impact of this erosional phase are still unclear in the best-known geoarchaeological studies.

To illustrate the complexity of this example, let us consider a very localised but informative case-study

from the island of Euboea. Excavations at the ancient city of Eretria were accompanied by geomorphological investigations in and around the site (Rust, 1978). Of particular interest is the sequence of river deposits in the alluvial plain to the west of the city wall, because here a phase of major stream flooding and alluviation bearing hinterland erosion products, interdigitates with a well-dated stratigraphy around the ancient West Gate. The erosion phase occurred in the late C5th BC, bracketed within a few decades since C4th graves were dug into its sediments. There was no subsequent major erosion period till early Modern times in this area. What then was the historic context of the major slope failure? The town of Eretria is founded in the C8th BC and rapidly develops into a major populous city. Despite the erosion evidence, there is no trace of decline during the Classical period, with vigorous building activity in the urban zone in the C4th BC. Eretria in fact remains the second most important town on the large island of Euboea into Early Roman times. Rust finds a uniformitarian parallel for the likely sequence of the late C5th BC in a very recent phase of soil erosion, alluvial bed widening and stream terrace aggradation; in the Early Modern period a major expansion of local village agriculture is associated with renewed clearance for olive plantations, provoking slope destabilisation. Significantly the resultant phase of erosion is not claimed to have crippled village productivity, and the stream concerned is now stabilising through renewed incision. Rust's model cycle envisages 'normal' modest soil creep building up slope deposits without disrupting agriculture, associated with solute sediment bedloads and stream incision; this scenario is punctuated very irregularly by short-lived episodes of dramatically-heightened soil erosion, in which high suspended sediment loads stimulate streams to shift from meandering to braided regimes, accumulating alluvial deposits until the sediment supply dries up naturally. Whether a short phase of dramatic land-clearance is sufficient in itself to provoke such a brief episode of aggradation, or whether the direct cause might rather be sought in a limited period of regionally-confined extreme rainfall events, remains a central question for future research (see below for further discussion in the context of recent work elsewhere in Euboea).

ANOTHER ANOMALY: THE BOEOTIA REGION, CENTRAL GREECE

The Boeotia Survey, a regional archaeological and geographical project running since 1978 under the

co-direction of myself and Anthony Snodgrass, has documented the same kind of long-term demographic cycles as those found in similar surveys in the Argolid and elsewhere in Mainland Greece (Bintliff & Snodgrass, 1985, 1988 a; Bintliff, 1991). Given the close association drawn by van Andel and co-workers between the rise and fall of regional populations in later prehistory and historic times, and the restricted but major phases of erosion and valley fill already discussed in this paper, we were expecting to find the Boeotian landscape likewise marked by a series of major erosion episodes. Eberhard Zangger, one of the key geomorphologists in van Andel's team, came onto the Project in the early 1990's to commence the analysis of our alluvial fills. After some days field-work however, he reported that there was no sub-project worth carrying out, as our survey area did not appear to have witnessed major Holocene erosion! Subsequent work over several seasons by the Project soil scientist – Rob Shiel of Newcastle University – has provided additional information on these important issues (Shiel, in press). The main agricultural soils of Boeotia rarely exhibit fully-developed profiles, with poorly-developed A-horizons and often an absence of a B horizon; they frequently rejuvenate from soft-rock bedrock via weathering into the C horizon. Given that Boeotia lies in a less arid climate than neighbouring Attica, Euboea and the Argolid, one might have expected during early Holocene times, under a full woodland, that soil development was initially fuller. The most likely time when soil truncation and underdevelopment began to operate would have been the first extensive clearance of woodland during mature early farming times. Our survey clearly indicates the Final Neolithic and Early Bronze Age as the critical era for the expansion of farmers across the landscape. Nonetheless, although it can be expected that some slopewash occurred at this time, together with the rapid decline of a rich organic A-horizon as trees were replaced by prolonged cropping, it appears that massive soil erosion along the lines of the Argolid or Attica was not stimulated. This might be compared with Rust's demonstration on Euboea of a steady accumulation of short-distance colluvial cover in cultivated landscapes without catastrophic implications.

My provisional interpretation of this anomaly would be that the pre-adapted open landscape, hitherto protected by woodland for the most part, was far less prone to, or just did not experience, the extreme weather conditions to be found in the arid zones further south and east in Greece. Soil loss was minor. Moreover, with moderate rainfall usually assured, and

plentiful soft bedrock to make good any physical topsoil thinning, populations were able to continue to cultivate the same soils up to the present day. Rob Shiel points out, that it is difficult to argue that the population collapses observed at the end of the Early Bronze Age and in Hellenistic times in Boeotia, identical to those found elsewhere, were due to erosion; firstly – as noted – topsoil loss was minor, and secondly we can observe that recent populations (including those of the pre-chemical fertiliser period) have managed to achieve high densities through cultivating exactly the same truncated and under-developed soils. A more likely factor, if we were to look for ecological problems, in both my and Rob Shiel's view, is *cyclical* decline in soil nutrients due to overcropping and inadequate manuring.

Nonetheless, it remains to be shown that Bronze Age population densities were ever high enough in Southern Greece to achieve sufficient soil nutrient collapse so as to have affected the stability of contemporary societies. The general collapse of Early Bronze Age populations and social complexity throughout Southern Greece remains therefore insufficiently accounted for. In some areas but not others, there is a link to massive soil erosion. There could well be some connection to contemporary settlement collapses in the Near East, which have there been linked to a short-lived climatic downturn. Perhaps overuse of soils and inadequate manuring added to the cumulative effects of erosional and climatic pressures. Finally political troubles were certainly involved – since fire destruction is widespread at many key sites in Southern Greece.

Boeotia can also shed significant light on the Hellenistic or late Classical depopulation phenomenon. Unlike Euboea, Attica and the Argolid, soil erosion cannot be a major factor in the identical Boeotian decline. Here though, our argument that nutrient decline in agricultural soils is a potential cause of depopulation and economic crisis finds stronger evidence. Firstly our work on historic sources and the field survey indications for settlement size and density have led us to argue that Boeotia in later Classical times was probably very overpopulated – on a scale that could not have been sustained in the long-term by local food production (and food imports do not seem to have been normal in this society). Striking confirmation that the cost of continuous overcropping of land was leading to declining yields comes from our Survey's careful mapping of so-called 'offsite scatters' i.e. broken pottery found across the landscape *between* occupation sites. In the southern hinterland of the ancient city of Thespieae,

for example (Fig. 9), over an area of 5.2 square kilometres, average density of surface pottery comes to 2635 sherds per hectare, or 1.37 million pieces in total. Samples collected for dating show that 3/4 of this material is confined to one period – the Classical Greek era. Analysis of the density and distribution of the offsite material demonstrates that it is almost entirely the result of highly-intensive manuring of cultivated land (Bintliff & Snodgrass 1988b, Snodgrass 1994), in the main from city-dwellers, with a lesser contribution from rural settlements spreading their household and farmyard rubbish onto adjacent fields.

The concentration of manuring into the period of postulated maximum pressure on the land, and our belief that contemporary cropping was unsustainable in nutrient terms – even with continual manuring – does allow us to suggest that here at least the subsequent depopulation and well-documented economic crisis of Boeotia during Late Hellenistic and Early Roman times were significantly related to an ecological crisis. Elsewhere, in the more arid landscapes where erosion occurred during this timescale, we might suggest that nutrient problems were exacerbated by topsoil loss.

RECENT RESEARCH IN SOUTHERN EUBOEAE

Indeed, striking agreement with the predictions of this model might be seen in the recent geoarchaeological studies carried out by De Dapper and colleagues in collaboration with Canadian archaeologists in Southern Euboea, Greece (De Dapper et al., 1997). As in Boeotia, there is a vigorous expansion of Classical Greek farming sites across the landscape, but here that includes the intensive agricultural exploitation of land that may never have boasted a rich soil cover, even under primary earlier Holocene woodland. This settlement pattern is largely abandoned by later Hellenistic times, and from this time onwards there is evidence for soil erosion and alluvial aggradation, not necessarily continuously – but certainly active in Early Roman Imperial times and in the Middle Byzantine period. Since the Middle Ages, in contrast, the trend has been to linear incision, although renewed surface erosion in the most recent period is now claimed for abandoned terrace-walls (De Vlieghe et al., 1997).

The collapse of Classical settlement almost certainly long precedes erosion – rather than being its victim, and is either due to local political changes, or given the fact that this is an area with much poorer agricultural potential than Boeotia – might well have followed a

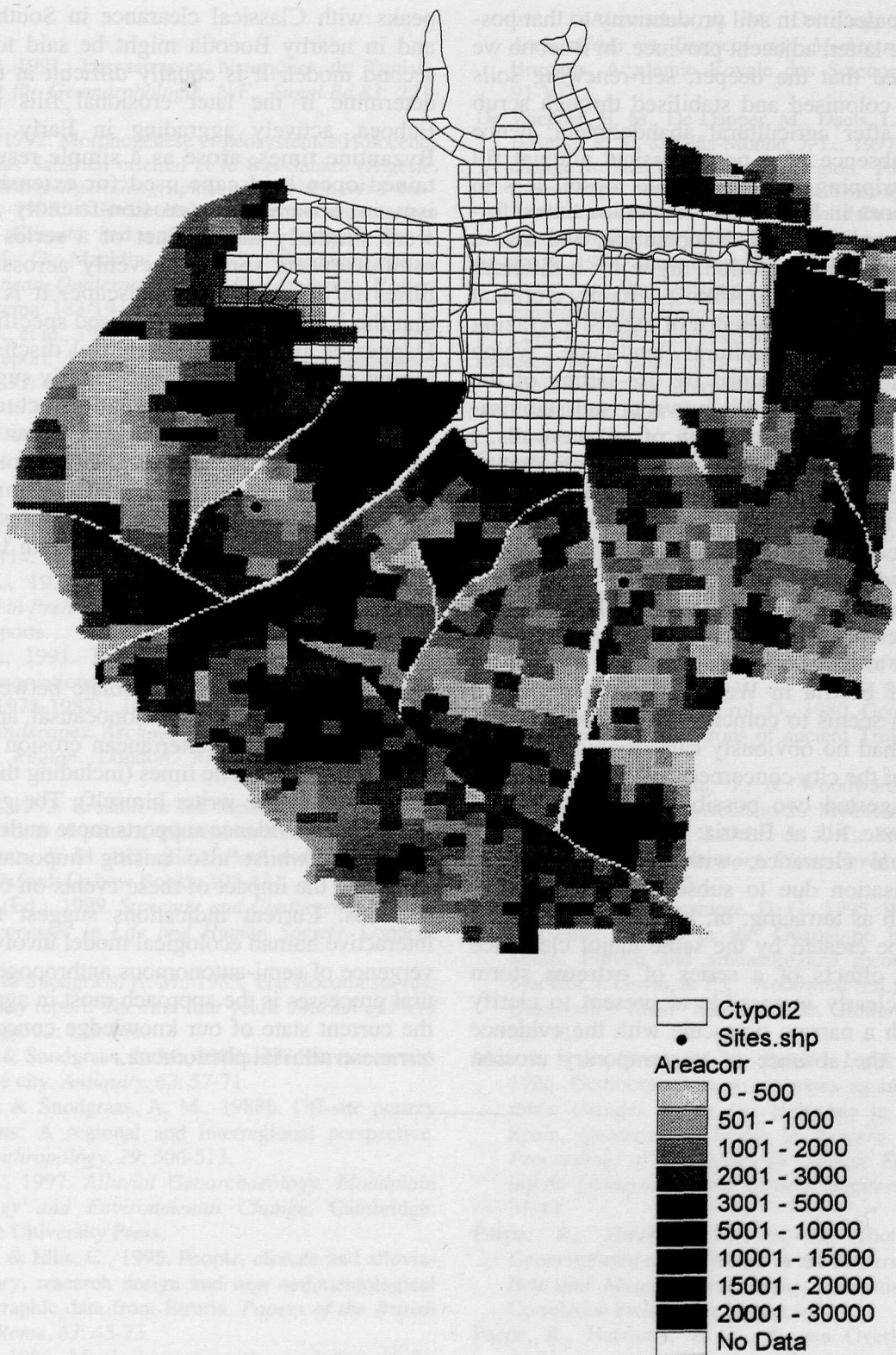


Fig.9: Density of surface pottery in the southern hinterland of the ancient city of Thespieae, Boeotia, Central Greece. Maximum area of the city is indicated by the survey grid at the top of the picture. Pottery density plotted by surface survey field transects in sherds per hectare. Rural archaeological sites of Greco-Roman date shown by small black circles. (Source: John Bintliff, Phil Howard & Anthony Snodgrass).

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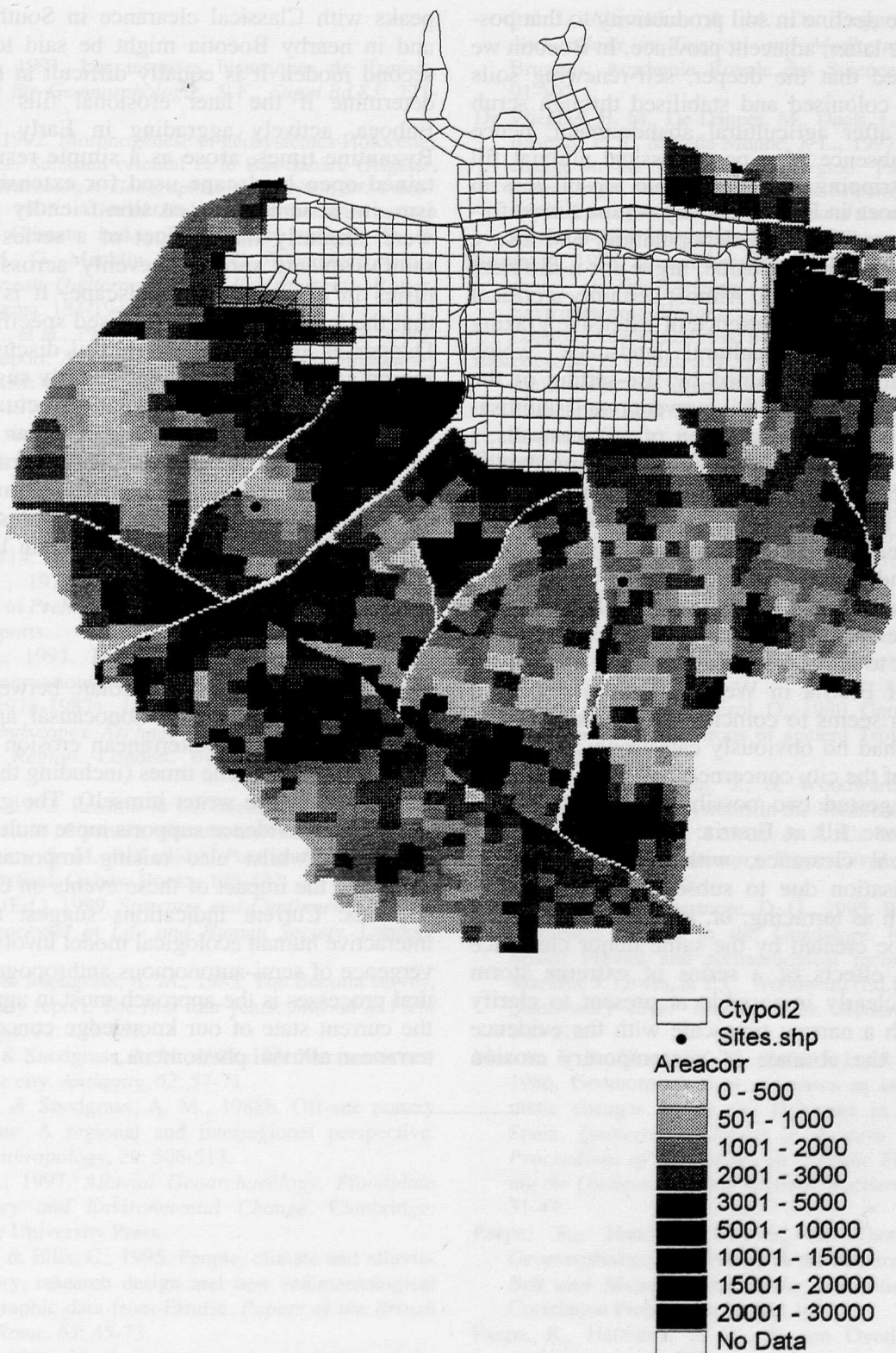


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similar drastic decline in soil productivity to that postulated for the latter, adjacent province. In Boeotia we have suggested that the deeper, self-renewing soils were rapidly colonised and stabilised through scrub regeneration after agricultural abandonment, hence the general absence of a post-Classical alluvial fill fed by soil-stripping. But the visible topsoil loss in Southern Euboea in Roman and Byzantine times, following the same Classical depopulation, and also a phase of recent terrace erosion, argue for a different scenario in that study-area. Almost certainly a critical difference could be the presence of extensive grazing across the former agricultural landscape, which would need to be maintained by fire-setting of the scrub on a regular basis; this prevents soil stabilisation and the natural conservation of terrace-walls. I would argue that extensive pastoralism preadapted the South Euboean landscape to episodic erosion.

Nonetheless, it is striking that the doubtless massive woodland clearance that inaugurated the Classical maximum land use in Southern Euboea, and the several centuries of very open agricultural landscape of Classical times, show no association with erosion – in clear contrast to the short-lived but major alluvial fill at the city of Eretria in Western Euboea discussed earlier, which seems to coincide with peak Classical land-use but had no obviously catastrophic effect on the fortunes of the city concerned.

We have suggested two possibilities for the single major Holocene fill at Eretria: either an unusually rapid Classical clearance, with soil loss peaking before stabilisation due to subsequent conservation measures such as terracing; or, a preadapted agricultural landscape created by the same major clearance suffering the effects of a series of extreme storm events. It is clearly impossible at present to clarify events at such a narrow timescale with the evidence to hand, but the absence of contemporary erosion

peaks with Classical clearance in Southern Euboea and in nearby Boeotia might be said to favour the second model. It is equally difficult at this stage to determine if the later erosional fills in Southern Euboea, actively aggrading in Early Roman and Byzantine times, arose as a simple result of a sustained open landscape used for extensive pastoralism in a semi-arid, erosion-friendly climate, or were similarly the product of a series of extreme rainfall events spread unevenly across many centuries in a preadapted landscape. It is noteworthy that the latter possibility is raised specifically by De Dapper et al. in their thoughtful discussion of the region's alluvial history. Particularly suggestive of a decisive role for minor climatic fluctuations is the evidence for a general regime of linear stream incision for most of the post-Byzantine era (something generally true throughout the Mediterranean lands – cf. Bintliff, 1977a,b), despite the widespread availability of topsoil disturbed by human land use and abuse.

CONCLUSION

This study has sought to mediate between the more extreme deterministic or monocausal approaches to Greek and wider Mediterranean erosion and alluvial processes in Holocene times (including those formerly expounded by the writer himself). The growing body of empirical evidence supports more multicausal interpretations, whilst also raising important questions regarding the impact of these events on contemporary societies. Current indications suggest that a more interactive human ecological model involving the convergence of semi-autonomous anthropogenic and natural processes is the approach most in agreement with the current state of our knowledge concerning Mediterranean alluvial phenomena.

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NOTES

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