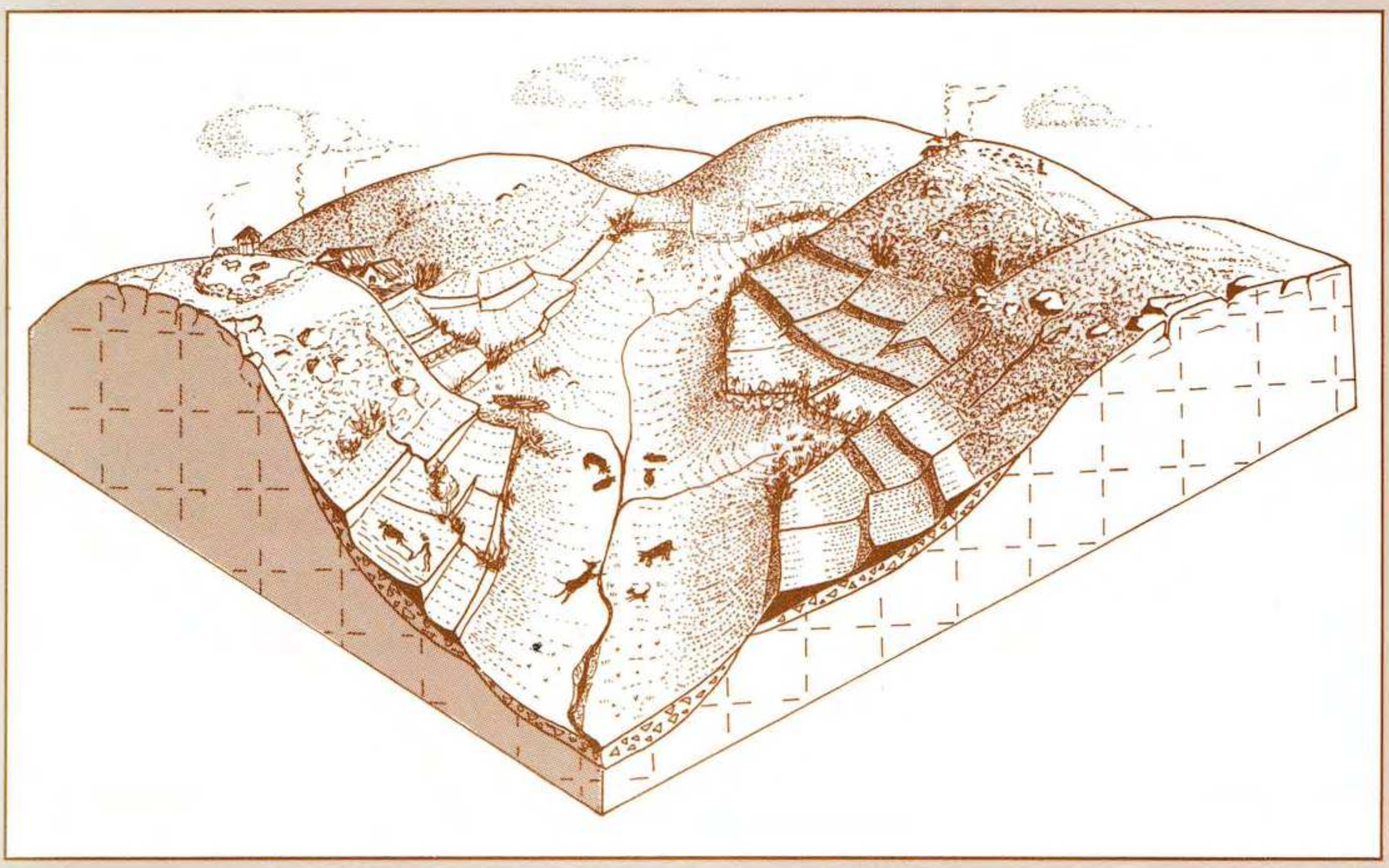
Past and Present Soil Erosion

Archaeological and Geographical Perspectives



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CHAPTER 12

NEOLITHIC TO PRESENT SOIL EROSION IN GREECE

EBERHARD ZANGGER

The first Post-glacial events of soil erosion occurred time-transgressively in different parts of Greece. Regardless of the area of observation, the earliest Holocene phase of soil instability has been most significant with respect to the quantity of moved material. Furthermore, human clearance of the natural vegetation on slopes, accompanying the introduction of widespread agriculture, appears as the most likely cause of the first landscape instability. Later soil erosion occurred with increasing frequency and decreasing magnitude, since most fragile soil had already been washed away. New data from the Berbati-Limnes area provide striking evidence in support of a human cause of prehistoric deforestation and soil erosion at the Neolithic/Early Bronze Age transition. The first seeds of agricultural communities arose in the Argive hinterland during the Middle Neolithic. By the Final Neolithic/Early Bronze Age transition their number had increased by a factor of five; subsequently, during Early Helladic II, it soared even more dramatically. A pollen diagram from the coastal swamps near Lerna records a drastic decline of the formerly dense oak forests in favour of Hornbeam (Carpinus) and evergreen shrubs and trees which coincided with the population increase at 4000–3000 BC. The palynological evidence by itself argues unequivocally for a strong human impact on the natural vegetation ultimately resulting in large-scale soil erosion.

Introduction

Imagine a survey team of six people searching in a sparsely vegetated terrain for artifacts. The first team member (Figure 12.1A:1) finds exposed white marl with big, square limestone boulders and many well-rounded pebbles but no sherds. The second person (Figure 12.1A:2) reports a dark brown soil with many artifacts, while her neighbour to the right finds only sterile, exposed marl. The fourth team member walks on red soil, and the fifth on white marl and finally the sixth on red soil again. All individuals notice big, square limestone boulders and much smaller, well-rounded pebbles. What is going on?

The answer is quite simple: they are surveying along the boundary between exposed marl and an alluvial fan (Figure 12.1B). The large unrounded limestone boulders have fallen down from a nearby bedrock slope while the smaller rounded pebbles were originally interbedded with the marl and have weathered out. All surfaces, limestone, marl and alluvial fan have been stripped of their soils. The two bedrocks, limestone and marl, lie barren and exposed, while the alluvial fan displays a truncated Pleistocene palaeosol (Table 12.2). With the Holocene soil, most evidence for human occupation has been washed away. Only in one patch, under the tree in the second transect, do remnants of the previous soil cover remain and these do indeed contain artifacts indicating past human land use. Pottery fragments and grinding stones indicate an agricultural community (Figure 12.1C). How extensive this site was and how thick the soil is everybody's guess. The evidence is gone. From this place we cannot even determine when it disappeared. At an earlier stage, before human occupation, the whole area may have had a considerably thicker soil which probably supported a dense vegetation (Figure 12.1D).

This introductory example was drawn from observations made during fieldwork conducted from 1987–90 in the Berbati-Limnes area just east of Mycenae on the Peloponnese. Today, this landscape represents an erosional environment dominated by barren limestone hills. Numerous terraces have been erected to prevent the last vestiges of soil from further destruction. The erosion which occurred here and elsewhere in Greece before such terraces were built is the subject of this study. The questions to be answered are: when did the erosion occur, what caused it and what are its consequences for the archaeological record?

A status report

These questions are not new. Only ten years ago it seemed as if a straightforward answer had been found for both the date and mechanism of soil erosion in Greece (Bintliff 1977; Vita-Finzi 1978). During the last decade, however, a number of geoarchaeological projects have been carried out in Greece (Figure 12.2), for instance in Volos (Zangger 1991), the Argive Plain (Finke 1988), the Berbati-Limnes area (Wells *et al.* 1990), Asine, the Skourta Plain, in the Thessalian basin (Demitrack 1986; van Andel *et al.* 1990), the plain of Marathon (Baeteman 1985), the southern Argolid (Pope and van Andel 1984), Nemea (Wright *et al.* 1990) and in Kammena Vourla (Niemi 1990). Two recent synoptic articles summarized the most important results of these projects with respect to soil erosion and redeposition in Greece (van Andel and Zangger 1990; Zangger 1992a), concluding that the first Post-glacial soil instability occurred time-

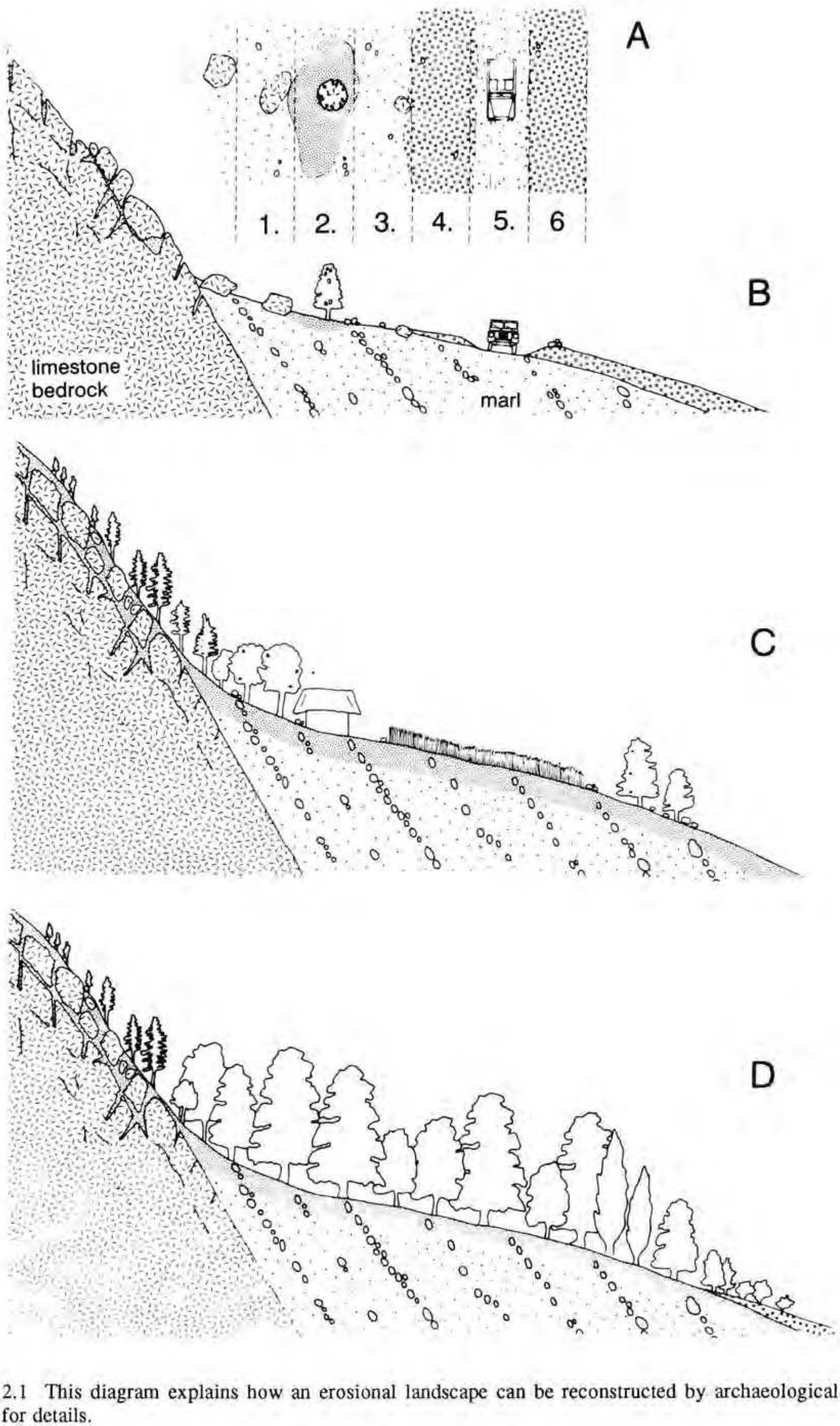

Figure 12.1 This diagram explains how an erosional landscape can be reconstructed by archaeological survey. See text for details.

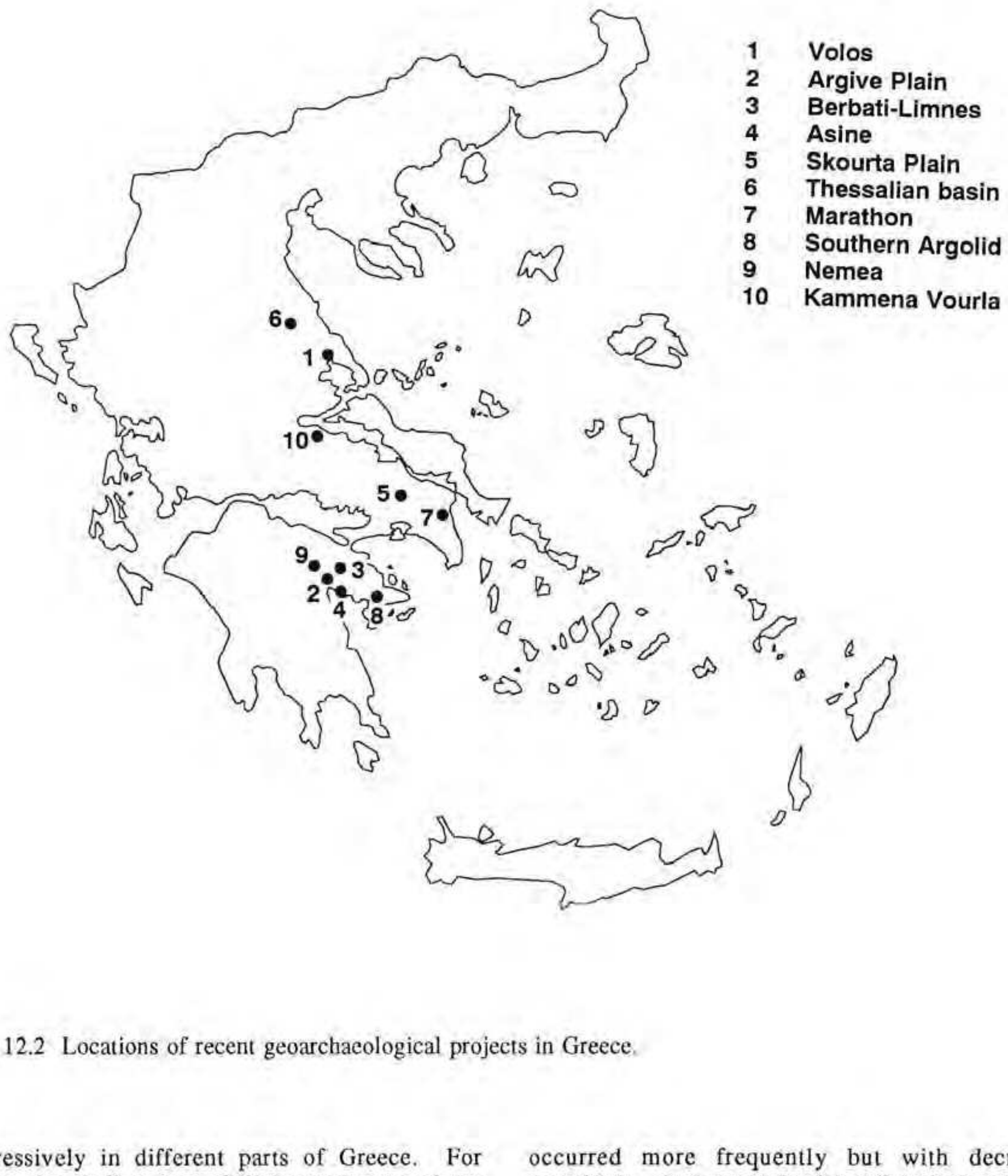

Figure 12.2 Locations of recent geoarchaeological projects in Greece.

transgressively in different parts of Greece. For instance, the shallow bay of Volos and parts of the Thessalian basin saw enhanced sedimentation during the Late Neolithic, while the Argive Plain and the Southern Argolid experienced soil erosion and redeposition mainly during the Early Bronze Age. The time transgressive occurrence of this initial phase of landscape instability follows the introduction of widespread agriculture in the respective areas with a few centuries delay. Thus it was concluded that human-induced clearance of the natural vegetation on meta-stable slopes represents the most likely trigger of the soil erosion. Regardless of the area of observation, this first Holocene phase of instability was also the most significant one in terms of quantity of eroded material. After the equilibrium had been lost, erosion occurred more frequently but with decreasing magnitude, since most fragile soil had already been washed away. The aim of the present publication is to illustrate these conclusions and to verify their validity in the light of new results obtained from an area that is characterized by soil erosion, the Berbati Valley.

Agriculture was introduced to Greece during the seventh millennium BC. For three to four thousand years, however, the farmers utilized only the most fertile and tillable soils in the plains leaving the hill slopes untouched. In remote areas of Greece, far away from human settlements, one can still today find examples of such largely undestroyed environments as they must have prevailed in the Neolithic. In these areas mature soil reminiscent of *Terra Rossa* and usually 20–100 cm thick covers the limestone upland providing the substrate for a healthy vegetation. In other places, where the equilibrium collapsed at some point in the past the mountains were stripped of their soil cover. Masses of eroded material were transported downhill and redeposited in topographically lower areas. Today, most Greek mountains are barren – with little or no soil cover left, they can only support a limited vegetation cover. The plains, on the other hand, are now filled with fertile alluvium often 5–10 m thick.

Soil erosion consequently caused the destruction of archaeological sites too, almost completely eroding settlements at higher elevations. Today, we can only discover vestiges of these sites without being able to tell how extensive they may have been and how many others may have disappeared completely (Cherry *et al.* 1988). At the same time the redeposition of the eroded material buried other sites in lower areas under several metres of alluvium, also concealing them from archaeological investigation. A Middle Neolithic site, marked by deposits rich in organic material, pottery fragments, charcoal and shells all dating to the middle of the sixth millennium BC, was found at 5–6 m depth in one auger core from the Argive Plain (Zangger 1992b). Such deeply buried or almost entirely eroded sites are chance finds and little can be said about the site pattern prior to the erosion.

Late Bronze Age residences in the plain of Argos, however, show thresholds level with today's surface. Thus, at least in this particular area, soil erosion and redeposition must have ceased by the end of the Bronze Age. While the above mentioned Middle Neolithic site at 5–6 m depth provides a maximum date for the alluviation in the Argolid, the Mycenaean houses built on top of the alluvium give a minimum date. Yet another settlement, dating to the Early Helladic II or Early Bronze Age II period at roughly 3000 BC, was found within the alluvium, thereby yielding a date for the landscape collapse itself.

Numerous indications supporting an Early Bronze Age date for the first widespread soil erosion were found during the work in the Argolid. The majority of sites and sherds dated to Early Helladic II, the time of the House of Tiles at Lerna and an impressive circular structure in Tiryns (Kilian 1986). Both buildings symbolize the existence of a thriving community. The Berbati and Nemea surveys in adjacent areas have shown a dramatic increase in population density during the Early Bronze Age (Wright *et al.* 1990; Wells *et al.* 1990). Furthermore, Professor Pullen from the Nemea project discovered the figurine of a draft animal dating to Early Helladic II pointing towards the importance of farming at that time (Pullen 1992). Although these indications of enhanced human exploitation are helpful, they do not provide solid evidence for man-induced land abuse. This evidence, however, comes from a pollen core that was taken from the swamps near Lerna during the course of the Argive Plain Project in 1987 and which has now been examined in Göttingen (Jahns 1990).

The core extended to the surface of the Pleistocene at 7 m depth, but the lowest 1.5 m did not contain pollen. The diagram starts at the time of the Post-glacial climatic optimum in the sixth millennium BC at 5.5 m depth. A characteristic of the lowest part of the pollen diagram is the prevalence of deciduous oak comprising an average 40% of the pollen material. Jahns presumes that oak forest covered higher elevations in the sixth and fifth millennium BC, while shrubs dominated the plain. Towards the end of the fifth and throughout the fourth millennium the climate became wetter or cooler enabling the oak forests to expand to lower elevations. At the same time non-tree pollen diminished pointing towards an unusually dense vegetation with few glades. The pollen diagram provides no indications for human interference during Neolithic times. Towards the middle and end of the fourth millennium BC, however, the vegetation changed rapidly and drastically. The percentage of deciduous oak dropped dramatically. Other species which thrive on cleared land (*Pinus, Erica* and *Carpinus orientalis*) increased pointing to human tree felling. Similar observations were made from pollen cores taken from Lake Kopais in central Greece (Turner and Greig 1975; Rackham 1983; Allen 1990). The beginning of the Bronze Age also saw an increase in olives but whether these were domesticated or wild olives which could have grown in the *maquis* following the land clearance cannot be established (Renfrew 1972; Runnels and Hansen 1986).

Deforestation by itself would probably not have sufficed to cause the extensive soil erosion which occurred in prehistoric Greece. Only the combination of tree-felling and expanding pastoralism prevented the vegetation from recovering. To illustrate the effects of pastoralism on individual plants Figure 12.3 shows a prickly oak which is one of the main *maquis* bushes in Greece usually about 1 m high. This particular plant, however, grew in the courtyard of a monastery where it was undisturbed for many centuries and where it could grow unrestrictedly to impressive size. Figures 12.5 and 12.6 show photographs taken (in Tunisia) on the same day at places only 10 km apart. The landscape in Figure 12.5 has been used for grazing, but the one in Figure 12.6 was abused by grazing.

If, however, soil erosion was triggered by local human land abuse, then one should be able to find places where no such extensive exploitation took place and where the landscape is still intact. Such a landscape can be found in the area around Skourta on the northern slopes of the Parness mountains between Boeotia and Attica (Figure 12.4). This area has few inhabitants and fields; hence, plenty of soil is left on the limestone supporting a healthy forest of deciduous and coniferous trees. For much of Greece's history the Skourta area was a borderland between opposing kingdoms (Munn and Munn 1989). It belonged to Attica although it is more accessible from Boeotia. Since the Boeotians were not allowed to utilize the land and the Athenians could not get to it, because it lies beyond the Parness mountains, the landscape was saved from human abuse. The extent of these forests can be traced on satellite images, showing that they roughly coincide with the boundary between the two states in Classical times. In Boeotian territory the

Figure 12.3 A prickly oak (*Quercus ilex*) in the yard of a monastery could grow unimpeded until it had reached twice the height of the nearby church

Figure 12.4 The slopes on the southern side of the Skourta Plain

plains were then, and are today, used for intensive agriculture. The Boeotian mountains are completely bare of vegetation and the same is true for Attica, with the exception of a protected no man's land in between.

In summary, the archaeological, geological and vegetational records in Greece point towards human induced soil erosion in prehistoric times. The onset of landscape instability varied from area to area depending on the cultural history. Places of intensive Neolithic cultivation often show extensive soil erosion accompanying human land use (Zangger 1991). Other areas experienced soil erosion at later stages; the Argive Plain, for instance, first became a major cultural centre in the Early Helladic II period and suffered soil loss at the same time. Again other areas in deserted mountainous regions, such as the Skourta Plain, may never have been over-exploited by man and therefore still possess intact soils and vegetation. Thus, there is no general pattern for environmental reconstruction. Each area must be examined individually.

The Berbati Valley: a case study

To validate the above conclusions a new project was conducted in the hinterland of Mycenae, the Berbati Valley (Figure 12.7), which constitutes an exclusively erosional environment lacking recent deposits that could conceal prehistoric sites. Although the low preservational potential of the area reduced the chance of discovering prehistoric monuments or undisturbed settlements that would help date Holocene processes, the lack of extensive alluvium did provide an opportunity to examine a representative cross-section of the artifactual evidence from all periods of human occupation. In this respect the area contrasts markedly with the adjacent Argive Plain, where Holocene deposits are up to 8 m thick, often concealing prehistoric sites completely. Yet, the two areas are related, although inversely, because much of the redeposited material in the Argive Plain's coastal zone may have had its provenance on the slopes of the Berbati-Limnes hills. Such a reciprocal relation between two adjoining landscapes confirms the above conclusion that there is no standard answer to Holocene landscape reconstructions.

Geologically speaking the Berbati Valley is relatively stable; there are no indications of recent tectonic movements, no significant Holocene deposits and although the landscape is characterized by soil erosion, this process is by no means excessive. Because this landscape was sheltered from dramatic natural changes in the recent past it has a high potential for recording human disturbance. Places with little or no disturbance of surface deposits are extremely rare and incipient soils on Holocene sediments (Table 12.1) only occur in the immediate vicinity of the ephemeral stream at the Mastos, the only Mycenaean citadel in the valley, while mature but truncated Pleistocene soils are found on alluvial fans (Table 12.2).

At first sight erosional environments may seem of lesser appeal to geoarchaeological investigation than depositional ones. In reality, however, the interrelations in eroded landscapes between bedrock, topography, soils, soil erosion and human land-use are of foremost importance to the understanding of the historic man/landscape interdependence. In addition to reconfirming the picture of man-induced environmental destruction in prehistoric Greece, the study of the Berbati Valley illuminates the multifarious links between landscape evolution and its history of utilization. Site location, site preservation and land-use have been recognized as dependent on the geological setting (Wells *et al.* 1990). After the completion of the fieldwork the list of detected interrelations can be extended to include for instance (Figure 12.8):

- topography and bedrock
- bedrock and soil distribution
- soil distribution and land-use
- land-use and site location
- soil erosion and site preservation

Many other links exist, for instance, between water and building stone availability and site locations. The one parameter in this ecosystem that is independent of the others is bedrock – it determines topography, soils and human land-use. The overall character of the survey area is dominated by two markedly different geological units: (1) metamorphic limestone in the Limnes upland terrain in the eastern half reaching almost 800 m above sea level, (2) erodible flysch and marl in the depression of the Berbati Valley itself which has its lowest point at about 140 m.

1. The so-called Pantokrator limestone dominates much of eastern Greece including the Argolid and the Limnes uplands. It formed during the Lower Triassic to Middle Liassic when carbonate-rich sediments accumulated in a shallow-water basin. These terrains are exceptionally homogenous and monotonous with respect to topography, soils and vegetation.

2. The flysch, on the other hand, originated during a later phase of tectonic activity in the Upper Jurassic to Lower Cretaceous. It is rather diverse and intercalated with marls, sandstones and conglomerates. The flysch and marl terrains are infinitely more suited to agriculture. In addition, their interlayered conglomerate and sandstone bodies offer valuable building stone resources and effective foundations for construction. Thus, the twofold division of the bedrock in the survey area is likely to be reflected in differences in land-use too.

Some of the interrelations detected in the study area include:

1. Bedrock/Topography

The most obvious effect of the distinct bedrock geology is a twofold division of the topography of the

Figure 12.5 Vegetation in the Zaghouan Valley, northeast Tunisia, used for husbandry without massive damage.

Figure 12.6 Vegetation ten kilometres from the area shown in Figure 12.5, this time hampered by overgrazing.

Depth (m)	Horizon	Munsell Colour (wet)		Munsell Colour (dry)		Texture	Structure	Consistency	Miscellaneous
0.0–0.1	A	10YR 4/2	dark greyish brown	10YR 4/2	dark greyish brown	silt loam	weak, very fine angular blocky	hard, sticky	incipient soil, very homogeneous deposit, no stratigraphy, no sherds, no human impact
0.1–0.3	B1	10YR 5/4	yellowish brown	10YR 6/4	light yellowish brown	silt loam	weak, fine subangular blocky	hard, very sticky	
0.3–1.9	C	2.5YR 5/4	light olive brown	2.5YR 7/2	light grey	silt	none	hard, slightly sticky	violently effervescent

Table 12.1 Soil profile (BV–SP–09) in a scarp near the dry stream a few hundred metres west of the Mastos in the Berbati Valley exposing almost 2 m of unstratified recent alluvium. One of the few places where material has been deposited, not eroded.

Depth (m)	Horizon	Munsell Colour (wet)		Munsell Colour (dry)		Texture	Structure	Consistency	Miscellaneous
0.0–0.2	Ap	7.5YR 3/4	dark brown	10YR 4/4	dark yellowish brown	clay loam	weak, medium granular	weakly coherent, slightly sticky	violently effervescent
0.2–0.3	B1	7.5YR 3/4	dark brown	7.5YR 4/4	dark brown	silty clay loam	weak, coarse granular	weakly coherent, slightly sticky	strongly effervescent
0.3–0.7	B2k	5YR 4/4	reddish brown	7.5YR 4/6	strong brown	silty clay loam	moderate, fine-coarse angular blocky	very hard, slightly sticky	strongly effervescent, lime in filaments
0.7–1.0	B2t	5YR 4/4	reddish brown	5YR 3/4	dark reddish brown	silty clay loam	moderate, subangular blocky	very hard, sticky	strongly effervescent some thin clay films

Table 12.2 Soil profile (BV–SP–07) in a road scarp a few hundred metres south of the Roman bath in the Berbati Valley showing soil profile on a Pleistocene alluvial fan.

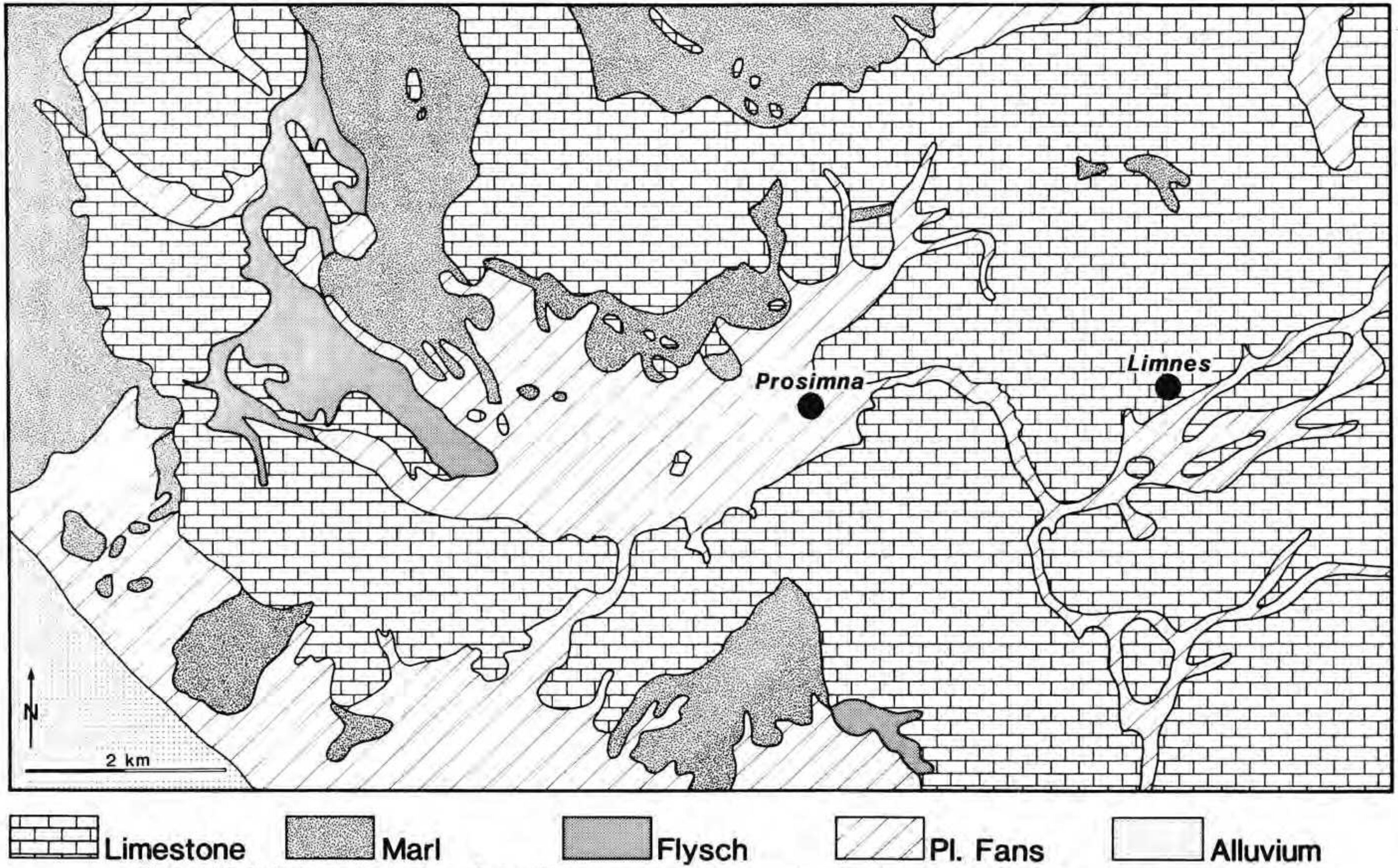

Figure 12.7 Bedrock distribution in the Berbati Valley according to the geologic map of Nauplion. Mesosoic limestone forms the Limnes uplands in the east and deeply eroded marl and flysch around Prosimna form the Berbati Valley. Prosimna is the modern name for the village which used to be called Berbati.

survey area. Because limestone withstands erosion effectively, it tends to form ridges often protruding several hundred metres above the floor of the valley, whereas the softer marl and flysch units form topographic depressions. The most sizable of these is the Berbati Valley itself. These physiographic differences – even without considering their impact on soil and soil erosion – have consequences for the human land-use, for instance, because olives do not grow at high elevations.

2. Bedrock/Soil

Even more important for agriculture are the quality and quantity of soil which again depend on the bedrock, considering that the climate is identical throughout the study area. The limestone terrains generally develop a clay-rich, dark red soil reminiscent of *Terra Rossa*. This soil forms exceedingly slowly; it is thin, highly fragile, but unusually fertile. Numerous limestone boulders within the soil often render it not tillable. Furthermore, limestone terrains usually include steep slopes, reducing the value of the land for agriculture. Soils on marl and flysch, on the other hand, form more quickly and are deeper than limestone soils, because precipitation and temperature fluctuations penetrate deeper into these less consolidated rocks. The tillage properties of the marls in the study area, though exceeding those of limestone soils, are still not excellent, because of intercalated layers of boulders and pebbles. Finally, marl and flysch terrains usually form gentle slopes which are quite suitable for agriculture.

3. Soil erosion/Topography/Soil

The level surface of softer bedrock areas is a sign of ongoing erosion. Wherever erosion takes place soils will not form, unless soil genesis exceeds the rate of erosion which is certainly not the case in the Greek dry climate where a mature soil probably requires a few thousand years to form even on soft rock like marl. Limestone soils are eroded because they are thin, fragile, often on steep surfaces and generally underlain by a flat interface to the unweathered bedrock. Marl and flysch soils, on the other hand, erode mainly because they rest on unstable substrates. Thus, soil distribution and erosion are attributes of a highly fragile ecosystem whose chief determining components are bedrock and climate. An undisturbed natural vegetation, however, might be able to provide a metastable equilibrium within this system; although it will not prevent erosion in general, for example through stream incision, it will reduce the potential of *soil* erosion.

4. Settlement and land use

Wherever people utilize a natural environment some particular characteristics of this ecosystem will be more important for them than others. The presence of fertile, arable soil and water, shelter from wind,

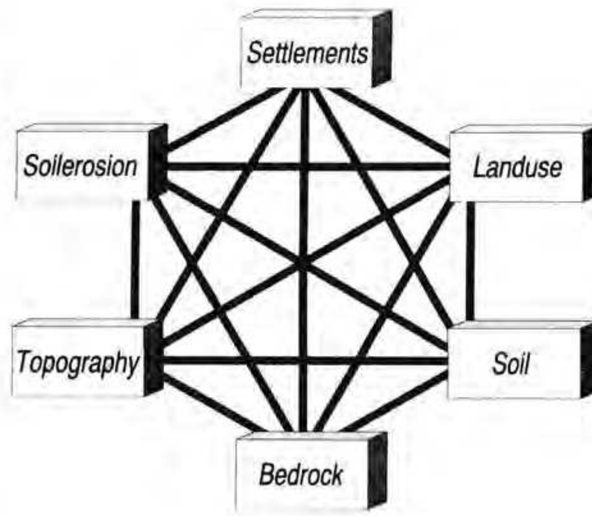

Figure 12.8 Interrelations between different components of the environment as recognized during the study of the Berbati Valley.

protection from the sun or exposure to it, availability of building stones, strategic control from elevated heights, remoteness and inaccessibility – all these attributes of the natural landscape have influenced people's site choice and land-use at one time or another. These interrelations between human land-use and natural environment and their fluctuations with time are evident from the archaeological record of the Berbati Valley.

The recently concluded Berbati-Limnes Archaeological Survey (Wells *et al.* 1990) has shown that the first human occupation of the Berbati Valley occurred during the Middle Palaeolithic when temporary visitors entered the area. A contemporary cave site at Kefalari in the Argive Plain may well have served as the permanent domicile of these people. For their unprotected open-air sites they only required access to perennial rivers and springs. Similar open-air camps of occasional visitors existed during the Mesolithic in the Kleissoura gorge, the entrance to the Berbati Valley, while the valley itself was apparently left undisturbed and only used as a hunting ground until the Middle Neolithic (*c.* 5500–5000 BC), when agriculture was introduced to the valley. The first farmers utilized different resources of the natural environment compared to those used by Palaeolithic and Mesolithic hunters and although they were again looking for access to water, among their prime concerns was deep, arable soil. Thus, agricultural communities arose near the centre of the valley at the Mastos and at Findspot 400 near Ayios Nikolaos.

Figure 12.9 First generation terraces on abandoned slopes between the Berbati Valley and the Argive Plain (east of Monastiraki). The terraces themselves are not visible from a distance, only the lines of shrubs whose roots provide additional support for the soil.

Figure 12.10 These terraces in the Limnes uplands belong to the second generation of terrace construction. They have been erected during the last 200 years and are still maintained today.

Figure 12.11 Detail of the terraces in Figure 12.9 showing the size of the boulders. Some of the rocks are up to 60 cm in diameter and because of their weight cannot have been brought there by individual farmers.

During the Late and Final Neolithic a prosperous village farming economy had been established on grain agriculture while the thriving settlements expanded into the higher plateaus. The increasing size of population and settlements, however, required clearing of so far undisturbed land for farming, including the bedrock slopes surrounding the valleys. The deciduous oak forests which initially covered these limestone hills were cleared to produce more grazing and farming land; the soil lost the protection from splash erosion and the support of roots and as a consequence it was washed away quickly.

During the Late Bronze Age when the Argive nobles established their residences on strategically elevated heights, such commanding positions began to play a role for site locations in the Berbati-Limnes area too. Nevertheless, habitation on lower ground continued in the form of small settlements, possibly farmsteads, on fertile land. The Mycenaean demise, however, brought a total abandonment of the area until the later Geometric period when it was resettled again. Within a few centuries, the population expanded dramatically to reach a high density in Classical times when even the remotest arable land was being exploited. At that time, however, terraces appear to have been in place to stabilize the soil and to prevent the kind of erosion which the land has suffered during the initial cultivation.

One of the most puzzling geoarchaeological problems in the Berbati and Limnes area are the agricultural terraces. They can be divided into two groups. Firstly, those still maintained today which tend to be 1–2 m high, 1–2 m wide and 10–20 m apart (Wells *et al.* 1990). They are typically found on limestone surfaces around Limnes and consist of relatively small boulders which can be carried by one person (Figure 12.10). The other generation of terraces dates back to an earlier time when every surface but limestone was artificially stabilized. Many of these former fields are found on the slopes surrounding the Berbati Valley which are no longer used for agriculture (Figure 12.9). These terrace walls, made of large boulders up to 60 cm in diameter (Figure 12.11), are often buried or overgrown by dense brush.

While the younger group of terrace walls dates to the last 200 years the age of the earlier one is unknown. It appears logical that they must have been erected during a time of dense occupation when even the remotest soils had to be utilized for agriculture. Such periods of high population density existed in the Berbati-Limnes area only during the Final Neolithic/ Early Helladic, the Mycenaean and the Classical periods. The first of these possibilities can be

Figure 12.12 The only place where first generation terraces are still maintained in modern (second generation) style. A whole sequence of walls has been erected in this area to stabilize a steep slope along the boundary of limestone and flysch.

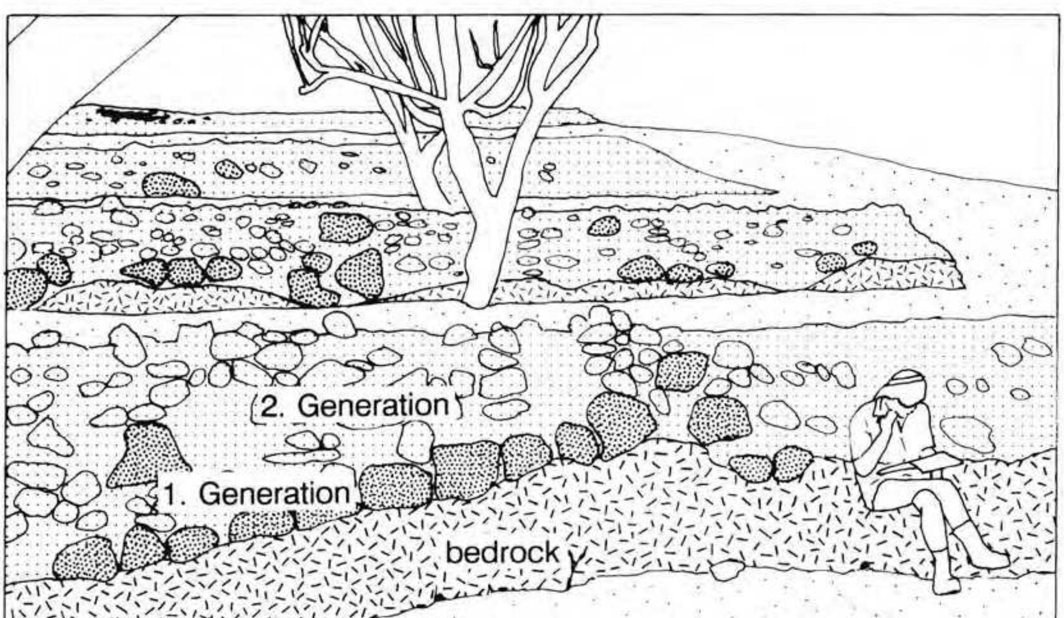

Figure 12.13 This sketch of the photograph in Figure 12.12 highlights the difference between first generation terraces consisting of large boulders and second generation terraces made up of smaller pebbles.

disregarded as a time of terrace construction, because the soil erosion in the Argive Plain post-dates this period and such large scale destabilization could not have occurred if the fields had already been protected by terraces. Thus, the Mycenaean and Classical periods are left as the most likely periods for terrace construction. The uniform character of the walls gives the impression that they had been erected during a relatively short time, possibly in some kind of community effort, since the boulders are too large to be handled by individual farmers. Furthermore, some ancient terraces had fertile top soil dumped behind them, which again points to a major and well-planned construction effort (Wells *et al.* 1990). Unfortunately, we are still unable to determine the date of this construction from the terrace walls themselves but one might be able to date them in the archaeological context.

Only in one remote area relatively high up in the mountains between Berbati and Limnes are terraces of the older generation combined with the later generation (Figures 12.12 and 12.13). In this area, the high relief between a limestone plateau and a pass of flysch has been very effectively stabilized by a sequence of up to 2–3 m high terraces. Some vertical bedrock faces appear at the bottom of the walls, which begin with a layer of large boulders, characteristic of the first generation terraces. The upper half of these walls, however, consists of modern-style terraces made up of small boulders. The whole system is evidently still maintained today. Sherds found in the area only date to the Classical period which therefore may well have been the date of the terrace construction. In fact, similar large-scale terracing projects from the Classical period have recently been described from southern Attica, where no artifacts from any other period are present (Lohmann 1985), thus at least the terraces in Attica are almost certainly of Classical age.

Conclusions

Population density in the Berbati-Limnes landscape has been low during the last few centuries and it was probably never much higher in earlier times. Because of the relative landscape fragility, however, the continuous disturbance of the natural environment by people has resulted in some profound changes, causing a decrease of soil quality, quantity and natural vegetation. As a consequence surface water has disappeared from an area where water mills were part of the scenery until the end of Turkish occupation. The groundwater level is sinking at an exponential speed today, due to the over-exploitation by farmers mainly from the eastern Argive Plain where groundwater has virtually disappeared. Soon, the human abuse of the natural resources in the Berbati Valley may once again, after the disastrous effects of deforestation in the Early Bronze Age, surpass nature's tolerance, causing unforeseen and potentially irreversible damage to the environment.

The study of the Berbati Valley has shown how different aspects of the natural environment and its utilization by man depend on each other and how these can be usefully determined employing an holistic approach. Like all other current palaeo-environmental studies in Greece it has demonstrated that landscape evolution cannot be reconstructed with a search for over-simplified model-oriented processes in mind. Although similarities and interrelations between different areas do exist, most land-forming processes are extremely complex and sometimes even inversely related. Hence, environmental evolution must be viewed as an intricate, multi-dimensional system with many interdependent parameters – one of which is the history of human land use.

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