Ecology in the Long View: Settlement Histories, Agrosystemic Strategies, and Ecological Performance

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The recent Columbian polemic contrasted beneficial New World land use before 1492 with destructive Old World land management. Since archaeologists are uniquely equipped to document and model long-term settlement and land-use histories, there is both challenge and opportunity to empirically examine the ecological impact of particular agrosystems within long time frames. This paper examines the risk-minimization and ecological fine-tuning of the Mediterranean agrosystem, and its long-term ecological performance. The Mediterranean ecosystem is the product of millennia of co-evolution between the environment and human activities, but traditional land use has been conservative and ecologically adaptive, despite sporadic disequilibrium. The deviations from the norm pose a number of testable hypotheses for further examination, not only in the Mediterranean region but also in other areas such as the New World.

Introduction

The recent polemic surrounding the Columbian Encounter served to underscore that the most interesting issues of today are those that cross disciplinary lines. Whereas theoretical debates within archaeology remain ignored by other social scientists, bioarchaeological research in Mesoamerica or the Pacific region is widely cited in the national or international literature dealing with human ecological impact. Archaeology was highly visible in earlier scientific exchanges about agricultural or human origins, and archaeology today not only has an opportunity but an obligation to become engaged in matters of the human use and modification of the environment. This paper juxtaposes questions of Mesoamerican and Mediterranean land-use and environmental degradation, centered on a regional explication of the complexity and sophistication of adaptive strategies in the Mediterranean world. The concluding section identifies questions that archaeology is particularly suited to address.

One of the unfortunate myths broadly disseminated before and during the Columbian polemic was that of ecologically-invisible New World peoples. Living in harmony with nature, Native Americans supposedly employed environmentally sensitive and sustainable agricultural practices that preserved the wilderness of the Americas with "barely perceptible human disturbance." That claim, legitimized by the Smithsonian volume, *Seeds of Change* (Shetler 1991: 226), flies in the face of generations of archaeological research that demonstrated large populations and intensified agriculture in Mesoamerica and other parts of the New World, including urbanism and complex social organization in some. Regardless of an ethos of harmony with nature, high population densities must be provided with food, and the record from North and South America provides countless examples of ridged or ditched fields, terraced hillsides, destroyed forests, or persisting roadways that supplied energy for great mound sites or monumental cities (Denevan 1992; Doolittle 1992; Whitmore and Turner 1992). To deny that New World peoples humanized and modified the environment, or created their own cultural landscapes, is to reinforce the metaphor of the 17th-century preacher, Cotton Mather, who referred to them as primitive aborigines, blending into the forest like beavers (see Zuckerman 1987: 144).

A more appropriate question to raise is whether the large populations in centers of New World civilization were able to grow and persist without ecological damage (Williams 1989; Butzer 1992a). Demographic pressures and finite resources will eventually curtail fallow cycles or require expansion of agriculture onto fragile soils, and the accumulating evidence reveals that there was no magical formula to avoid the ecological consequences. Around Texcoco, in the Basin of Mexico, Carlos Córdova (personal communication, 1994) has recently identified a series of late Aztec sites within massive sheets of alluvium, derived from soil erosion in the foothills. Similar implications follow from the limnological work of O'Hara, Street-Perrott, and Burt (1993) in the Tarascan heartland of Lake Patzcuaro, where indigenous land use provoked episodes of soil erosion as early as 1900 B.C., and soil destruction peaked during the three centuries prior to the Spanish intrusion. In the Mixteca Alta of Oaxaca, several protracted episodes of pre-Conquest soil erosion have been identified. Large-scale deforestation is even verified in Late Formative or Classic contexts in the Basin of Mexico (González, Fuentes, and Fuentes 1980) and coastal Veracruz (Byrne and Horn 1989).

Such evidence raises questions whether indigenous agriculture was indeed "sustainable," a question reconsidered below. It would also seem to urge caution against wholeheartedly embracing contemporary, traditional agriculture as a "system," rather than as a source of information to be drawn upon in selecting more beneficial agricultural practices and strains of crops (Butzer 1992a, 1993a). As repugnant as high-investment technodevelopment is to most of us, it would be irresponsible to recommend traditional land management practices simply on emotional or ideological grounds, without pragmatic testing and comparative evaluation.

Prehispanic environmental modification is quite pertinent for conservation arguments or issues such as biodiversity. The early Spaniards encountered deforested landscapes from Mexico to Panama (Sauer 1966: 265–88; Butzer and Butzer 1993), some of which had been reconstituted by a century ago, while earlier phases of deforestation are amply attested by palynology (Rue 1989; Abrams and Rue 1988; McDade 1994; Piperno, Bush, and Colinvaux 1991). Large swaths of the Peten rainforest were completely cleared 2000 years ago, but have since recovered sufficiently to be cited as reservoirs of primeval biodiversity (Rice, Rice, and Deevey 1985; Vaughan, Deevey, and Garrett-Jones 1985). That not only challenges some popular assumptions but, more constructively, could be used to estimate rates for the reconstitution of forests and their species diversity.

These are a few examples of archaeology interdigitating with problems of ecology, in both the past and present. Much of the primary work on environmental change, ecological degradation, or sustainability has been monopolized by biologists or earth scientists, who admittedly have the specialized skills requisite for certain categories of analytical research. But contemporary ecosystems are the product of millennia of co-evolution between environmental components and human activities, especially since the establishment of agricultural lifeways (Birks et al. 1988; Butzer 1990). Biologists are certainly no better qualified than archaeologists to deal systematically with the human side of that interrelationship. Like most larger problems confronting human society today, ecological issues are sufficiently complex to demand a new and greatly expanded medium of interdisciplinary interaction and collaboration. Archaeology should, indeed must, be a major player. It has unique capabilities, not only to generate an indispensable archaeological database, but also to understand long-term land use and its implications.

The Mediterranean Agrosystem: Fine-tuning and Risk-minimization

The Columbian polemic serves to highlight some critical issues of ecology in the long view, specifically the myth of the devastated Colonial landscape (Butzer 1992b). Did early European settlers indeed introduce agricultural methods, livestock, and technologies that promptly degraded New World ecosystems? As a categorical assertion it is the Mediterranean agrosystem, with its cattle, sheep, and plow technology that continues to be singled out as particularly destructive (Klein 1920; Simpson 1952; Sale 1990; Melville 1990). In reality there are two different issues here, one whether this agrosystem and its components are inherently destructive, the other whether the transfer of this agrosystem to the New World automatically had a negative ecological impact. The first of these questions will here be considered in some detail, while the second is reviewed in the final discussion.

The basic Mediterranean agrosystem that can be documented from Greek and Roman sources, or verified by ethnographic and archival work, was remarkably sophisticated (White 1970; Dimen and Friedl 1976; Spurr 1986; Delaigue 1988; Butzer 1993b, 1994; Wells 1992: 87–101; also Burford 1993). It had four basic components: a) outfield cultivation of a selection of grains and legumes, suited for local soils and climate; b) infield tending of various green vegetables and condiments, in kitchen or market gardens; c) orchard crops, not only grapevines and olive groves, but also an array of other fruit trees; and d) livestock, among which sheep, goats, or pigs were more commonly kept than cattle, with the exception of draft oxen.

But specific plants and animals are less informative for characterizing an agrosystem than their systematic integration in terms of ecology, scheduling and management, or cuisine (Butzer 1988b). Each of the components was carefully adjusted to the local environmental mosaic, and included winter as well as summer crops that were planted, tended, and harvested according to an elaborate seasonal schedule. Their micro-management included complicated instructions for plowing, spading, transplanting, grafting, pruning, selection or application of fertilizers, watering, and pest control. Intercropping was the norm for fruit trees and outfield crops, with a growing appreciation that grass fallow, nitrogen-binding legumes, and crop rotation all helped to maintain or restore fertility.

Stockraising included a nucleus of household animals, as well as herds of sheep and goats moved under close supervision within the municipal commonage or in a seasonal, transhumant cycle between lowlands and adjacent highlands (Vassberg 1984; Halstead 1987; Whittaker 1988; Butzer 1988a; Boyazoglu and Flamant 1992). Goats and sheep provided dairy products or wool, with selective culling of young male animals and occasional slaughter of an adult female in times of food shortage. Animal grazing on stubble after the harvest provided indispensable manure for outfield crops. Herds of pigs were restricted to environments with oak woodlands that allowed seasonal fattening on acorns. Finally, cattle were commonly raised on prime pastures and bred to produce draft animals. Only at the peak of Roman urbanism was cattle-raising practiced with improved breeds, to supply meat and dairy products to urban markets (White 1970; Garnsey 1988; Butzer 1992b).

This Mediterranean agrosystem emphasized risk-minimization, by a sequence of autumn, winter, spring, and early summer plantings that anticipated sporadic, early or late, killing frosts. The mix of outfield agriculture, orchards, and infield gardens with micro-irrigation all reduced the risks of prolonged summer drought. Livestock, less vulnerable to climatic perturbations by virtue of their mobility, offered another buffer against subsistence stress. Animals also supplied manure or fuel, fiber, and animal protein that further reduced subsistence risk. Finally, the production of grains, fresh vegetables, preserved fruits, cheeses and hams, leather or wool, and above all, wine and olive oil, represented a viable but flexible commercial component. That in turn favored intra- and interregional exchange networks (Renfrew and Wagstaff 1982; Osborne 1987; Garnsey and Whittaker 1983; Garnsey 1988). During periods of population growth and regional integration, such networks provided incentives for optimizing market opportunities, mitigating the dangers of periodic subsistence stress through interregional "averaging."

In view of the deep-seated North European and North American biases and misconceptions about the traditional Mediterranean agrosystem, it is ironic that it was one of the world's most diversified rural economies, its stability predicated on highly complex management. The interlocking, risk-minimizing strategies were so effective in anticipating periodic shortfalls that disastrous famines on the scale experienced in NW Europe during medieval and early modern times had no counterpart in the Mediterranean Basin. Furthermore, its commercial components could readily be scaled back during periods of declining urbanism, lower population levels, and reduced regional integration, but expanding again during times of economic and demographic growth. Thus rural populations could adjust their allocation of labor and surpluses to changing demand across the centuries, or compensate for local crop failures in some years by greater market returns during others.

Extensive pastoralism was integral to the flexibility of that agrosystem, as a means to utilize extensive mountainous landscapes unsuitable for agriculture, without competing for arable land. It also served as a "pioneer" form of land use in the resettlement of depopulated areas which could only gradually be converted to agriculture. Recent experimental studies of pasture management, productivity, and nutrient cycles have yielded unexpected results (Bernáldez 1995). Traditional management created a parkland vegetation of open trees through regular pruning and the controlled use of fire (Trabaud 1991). Wild and semi-domesticated legumes were naturally dispersed through livestock movements, enriching unimproved pastures with nitrogen as well as phosphates. The tree canopy favors microclimatic sheltering, and liveoak litter significantly improves soil nutrient levels. Even bushy or shrubby *matorral* vegetation protects against erosion and enhances infiltration, while its leaves provide browse and its woody parts can be converted to charcoal.

In other words, the ecology of supposedly unimproved pasture land in the Mediterranean Basin is largely beneficial, its structure and dominant forms reflecting coevolution in response to summer water stress and human manipulation (Bernáldez 1991, 1995). Such managed environments represent a controlled subclimax formation and are known by the Spanish term *dehesa*. From this perspective, transhumance can be seen as an effective complement to agriculture as well as a sustainable form of utilization for marginal lands. Mediterranean agropastoral systems were not only tightly integrated but carefully managed. The demise of pastoralism during the last 50 years, in part under government pressure, has led to expansion of unproductive, thorny and bushy *matorral* (Tomaselli 1977; Montoya Oliver 1983; Bernáldez 1991). Much like the analogous chaparral of southern California, it is a potential tinderbox, waiting to explode in wildfires that also destroy interfingering woodland (Le Houerou 1987).

The Bottom Line: Long-term Performance of the Mediterranean Agrosystem

This ecological analysis of the Mediterranean agrosystem serves to explicate the complex web of strategies that are designed to minimize vulnerability and risk. They reflect not only the cumulative experience of 10 millennia of agricultural trial-and-error in a summer-dry, subtropical climate, but also local and external innovations that were tested, adapted, and disseminated. This historical trajec tory can be amply reconstructed by archaeology and documentary sources. It can also be independently monitored from geoarchaeological records of alluviation in response to soil erosion, or from bioarchaeological data on changing vegetation. There now are over three dozen, detailed and dated pollen cores from all around the Basin that record local land use and ecological modification over at least the last six to eight millennia.

Without elaborating on that investigation and its methodological underpinnings here, these palynological data allow a) qualified distinction of pastoral and agricultural "indicators", b) identification of basic agricultural modes, and c) semiquantitative assessment of vegetation distur bance, deforestation, or secondary regeneration of woodland (Bottema, Entjes-Nieborg, and van Zeist 1990).

Such results diverge from charcoal or seed identification from site flotation studies, because they represent a composite picture for a larger area, much of it unutilized, rather than the disturbed environs of a site. Pollen spectra of the same age from a lake or swamp core and from an archaeological site within the same watershed also are radically different (van Zeist and Bottema 1991: fig. 41a versus 41b). Long pollen cores tend to be limited in resolution by sampling intervals, and dating must all too often be interpolated between widely spaced radiocarbon dates. Yet the advantages are obvious, with a relatively continuous trace of composite ecological change, sometimes punctuated by strong regional perturbations, compared with the discontinuous records and much sparser or secondary arboreal record typical of charcoal and seeds from an archaeological site (see Vernet, Badal, and Grau 1983; Vernet, Thiebault, and Heinz 1987; Miller 1991). This is primarily a matter of scale, but it is more than that, because survival of more distant woodlands within the same watershed facilitates ecological recovery as the degree of disturbance is reduced. In that sense the multiple watersheds of complex environments such as those of the Mediterranean Basin also differ fundamentally from mid-oceanic, island ecosystems, the ecology of which can be more rapidly and perhaps irretrievably degraded (Flenley et al. 1991; Kirch et al. 1992).

Equally so there are problems in reconciling pollen core data with episodes of destructive land use inferred from soil erosion as recorded in dated colluvium or alluvial fills. Such geomorphological criteria normally are discontinuous, documenting ruptures of soil and slope equilibrium (van Andel, Zangger, and Demitrack 1990; van Andel and Runnels 1987). Yet the nature of cause-and-effect in the crossing of such a threshold is open to interpretation, in part because channel fills, overbank deposits, debris flows, and colluvial spreads reflect different processes, and it remains difficult to exclude extreme weather events and their recurrence interval from a complementary role in erosion or deposition. Equally difficult is exact dating and accurate correlation with a particular stage of a local settlement history (e.g., Wells, Runnels, and Zangger 1990; Bell and Boardman 1992: Section C). For example, does initial clearance, long-term pressure, or the construction or partial (versus total) abandonment of agricultural terraces push disturbance or degradation beyond that critical threshold that promotes soil erosion in a particular area? Last but not least, a pollen core will sample a unique column of sediment, whereas soil erosion data are spatially distributed in a complex landscape, or must be linked by difficult lateral correlations. Not surprisingly the results may diverge, as evident from comparison of two interpretations of Lake Lerna in the Greek Argive Plain (Jahns 1993 versus Zangger 1991). Ideally, palynological records should be supplemented by measurements of magnetic susceptibility that give a continuous, quantitative trace of mineral sediment accretion, potentially sensitive to soil erosion in the catchment.

For our purposes, episodes of soil erosion give a signal for disequilibrium that complements the palynological data interpreted here. Ideally all these categories of infor mation require comparison and discussion, against a background of regional settlement history (that is rarely available), but that indeed would require book-length presentation. What follows is an outline that seeks to identify basic patterns and place certain archaeological issues into focus.

In general, vegetation was relatively undisturbed until about 5000 B.C. (calibrated) in the eastern Mediterranean region and until roughly 2000 B.C. in the western Basin. Nonetheless, there were scattered episodes of moderate to intense disturbance, due to agropastoral intrusion into local catchments, generally followed by partial or complete woodland recovery. There also is some evidence of soil erosion, varying greatly in intensity from place to place, and timing (van Andel, Zangger, and Demitrack 1990; Brückner 1986; J. T. Abbott, personal communication, 1994).

A combination of agriculture and incipient arboriculture (chestnut, walnut) is first evident in Syria by 5000 B.C. and in Greece about 3000 B.C., but olives or grapes, as a hallmark of true Mediterranean agriculture (Goor and Nurock 1968; Stager 1985), are only verified later: in Palestine shortly after 3500 B.C.; in Greece about 2000 B.C.; and in the western Mediterranean after 500 B.C. (Baruch

1986; Jahns 1993; Reille 1979, 1984; Runnels and Hansen 1987; Reille and Lowe 1993; Menéndez Amor and Florschütz 1961). That E-W gradient is compatible with direct archaeological evidence for olives or grapes or their products (Jashemski 1979; Stager 1985; Heltzer and Eitam 1987; Zohary and Hopf 1993), as well as for plow agriculture and possibly hillside terracing (see Wells 1992: 29–57, 123–130). In some places, but not in others, the apex of agricultural development led to modest soil erosion (van Andel, Zangger, and Demitrack 1990; Butzer 1993c). Unexpected is that this agrosystem subsequently was regressive, as early as 300 B.C. in some areas, or as late as A.C. 1000 in others, with woodland reconstitution during the early or late Middle Ages (Reille 1976, 1977; Lamb, Eicher, and Switsur 1989; Bottema 1984; Kuniholm and Striker 1987).

Local agricultural decline during Classical times (Argive Plain: Jahns 1993; western Anatolia: van Zeist and Bottema 1991) reflected provincial, urban decay in some areas controlled by Rome and may have been accentuated by soil destruction. Agricultural recession is also apparent during the Greek Dark Ages about 1000 B.C. (Bottema 1984). Distinctive in several areas is strong pastoral disturbance, in western Anatolia and northern Greece about 1200 to 800 B.C. (Bottema 1984; van Zeist and Bottema 1991: 82), in Iberia around 1000 to 500 B.C. (Stevenson and Harrison 1992), or in Palestine and Northwest Africa from A.C. 900 to 1400 (Baruch 1986; Reille 1976, 1977; Ritchie 1984). These represent times when the areas in question were exposed to pastoralist invasions from either temperate Europe or the adjacent deserts, and such disturbance sometimes led to substantial soil erosion. Ironically, however, the pollen records of northern Greece show that forest degradation increased species diversity by an order of magnitude (Bottema 1984); biodiversity issues in tropical and temperate forests are not identical.

A combination of charcoal studies and palynology suggests that increasing human modification of the environment accentuated a climatically-induced vegetation shift during mid-Holocene times, favoring a change from deciduous to live oak woodland and an increasing prominence of matorral, beginning at some point between 4000 and 2000 B.C. (Vernet, Badal, and Grau 1983; Vernet, Thiebault, and Heinz 1987). A recent, discriminating study in SW Spain (Stevenson and Harrison 1992) argues that experimentally managed grazing, by means of controlled use of fire, was underway since 4000 B.C.; by 500 B.C. the local dehesa system had been perfected, with no basic change through Roman, Islamic, or Christian times. Alternatively, in the temperate woodlands of Anatolia and northern Greece, sylvopastoral practices favored some trees over others after about 1700 B.C. (Bottema 1984; van Zeist and Bottema 1991).

This synopsis gives a glimpse of the complexity of ecology in the long term. The history of land use and landscape ecology in the Mediterranean Basin was a checkered one, with punctuated changes, long intervals of stability, and shorter episodes of mismanagement, periodically interrupted by ecological recovery. Despite a recent spate of archaeological or documentary studies devoted to long-term settlement and land-use, particularly in Greece (e.g. Renfrew and Wagstaff 1982; Keller and Rupp 1983; Snodgrass 1987; van Andel and Runnels 1987; Cherry, Davis, and Mantzourani 1991; Wells 1992), but also in the Levant and Spain, the rural histories of large areas remain little explored. But what stands out is that this relatively modest environment has supported agricultural populations across 5–10 millennia, and urban societies for some 2000–4000 years. Whereas the landscape has indeed been humanized, modified, impaired, or altered, traditional agropastoral systems have maintained their basic productivity across 200 generations or more. For all purposes, in the long test of history, Mediterranean land-use systems have been *sustainable*, despite sporadic evidence for destructive human intervention in time and space.

Implications for Mesoamerican Land-use Histories

This Mediterranean record appears to be analogous to the more fragmentary evidence currently emerging from Mexico and Central America. That should not be surprising because long ecological records will not reflect an idealized relationship between people and their environment, but rather the harsh realities of events or circumstances that could not be controlled. Intervals of destructive land use in Prehispanic Mesoamerica are not an indictment against the conservationism of New World agrosystems, any more than they are of their Mediterranean counterpart. Both traditions embodied millennia of experience that was translated into a refined system to minimize subsistence risk. Both, in the main part, were successful in achieving that goal, although internal or external stress at times required a shift of priorities to short-term survival, with unfortunate but not generally irreversible ecological repercussions.

Just what happened when the Mediterranean agrosystem was transferred to Mexico and "superimposed" on indigenous systems? The limited impact of Spanish livestock and agriculture, as now documented (Butzer 1992c, 1995; Butzer and Butzer 1993, 1995), is once again counterintuitive:

1. The Spanish-Mediterranean agrosystem was simplified in the New World, because of ecological constraints, insufficient manpower or agronomic expertise among the European settlers, and limited economic competitiveness versus indigenous agricultural productivity and products.

2. The indigenous agrosystem expanded its own repertoire of cultivars, especially by incorporating Mediterranean fruit trees in the highlands, or citrus fruits and bananas in the lowlands, the last introduced from Africa via the Canary Islands. Outfield and infield crops and management remained little changed.

3. Given the almost unlimited pastures lying beyond the northern limits of indigenous agriculture in Mexico, stockraising became less controlled but far more mobile than in the Mediterranean world. After initial conflict with indigenous farmers, stockraisers were pushed out to the frontiers by government policy. Balanced against damages sustained and lands lost, the indigenous peoples did derive important benefits from European livestock: reduced subsistence risk; improved nutrition with significantly more animal protein; and manure—for their fields or fuel for their fires.

4. Probably as a result of high livestock mobility, there is no evidence for vegetation change or soil erosion during at least the first century of colonization in Mexico—contrary to well-entrenched, popular assumption. But for reasons that are unclear, the Colonial government attempted to interdict fire management of range lands, possibly because it could not be properly controlled, as a result of the labor shortage and the inexperience of hired herders.

5. Finally, tangible evidence for ecological disbalance, including stream alluviation with eroded soil products, only becomes apparent during the course of the 18th century, a time of rapid demographic expansion (C. D. Frederick, personal communication, 1995; C. Córdova, personal communication, 1995). But that comes on the eve of proto-industrialization and in the wake of fundamental economic change, not only in Mexico but also in eastern North America.

Concluding Hypotheses

In retrospect, it is the temporary exceptions to agricultural stability in the long-term Mediterranean record that suggest the most interesting inferences.

Agrosystems evolve through trial and error; early agriculture was experimental in nature, and initial technostrategies were exploitative, and often ephemeral. Substantial ecological damage was done by very small groups of Neolithic people during fairly brief periods (Köhler-Rollefson and Rollefson 1990). Whether such events were so maladaptive as to require local abandonment and settlement dispersal into new areas (Butzer 1990) is unclear, but across some regions there are a number of intervals with very low archaeological visibility, typically lasting from 500 to 1000 years. Most of these fall between the early Neolithic and the early Bronze Age, and they are verified by local settlement surveys.

Cumulative experience should select for more conservationist strategies. By Bronze Age times much larger populations had less impact on forest or soil cover than did their Neolithic predecessors. *Subsistence experience is about how to minimize both long-term environmental damage and short-term subsistence risk.* Diversification of agronomic strategies was the key to reduced subsistence risk, as suggested by continuing amplification of the repertoire of orchard and garden crops, and tentative evidence that seasonal transhumance systems were being operationalized. Nonetheless, increasing and more persistent pressures on resources reinforced the Holocene climatic trend to a more xeric vegetation, thus creating the characteristic, subclimax vegetation communities of the Mediterranean world. From then on, the Mediterranean environment was more or less continuously managed as an artificial ecosystem that, on the whole, was sustainable.

Expansion and westward progression of the Mediterranean agrosystem, with its diagnostic olive and grape production, *represents both an intensification and commercialization of production, linked to the development of urban centers and their market demand.* Commercialization implies a redirection and refinement of management practices, such as the seasonal work calendar, in the direction of risk-reducing but production-satisfying strategies that meet market demand. That in turn requires intensification and greater capital investment—in technology, cultivars, livestock, and an appropriate infrastructure of buildings, roads, and agricultural landforms. Subsequent regression or reexpansion of such commercial agriculture should have closely paralleled regional, urban histories. At some point urban demand and high rural populations could place the ecosystem itself under stress, triggering periods of degradation.

Destructive pastoral land use was not endemic, but region- and time-specific. In part it was linked to the incursion of new peoples from other ecozones, suggesting *that prior environmental experience cannot be transplanted onto new ecologies without initial damage.* Only long-term environmental experience will encode reasonably accurate information as to how to use a particular environmental matrix, or as to the disposition of micro-scale activities, selection of crops and animals, and related management strategies. Equally so, however, uncontrolled pastoral exploitation was facilitated by political devolution. This suggests that *political instability and rural insecurity will* *reduce incentives for conservationist management of resources*, as long-term optimization takes second place to short-term survival.

Finally, simplistic assumptions about the efficacy of different land ethics in different cultures should be avoided. *Land ethics represent ideals, whether explicitly incorporated in the philosophical or cosmological realm, or transmitted in a more pragmatic and secular sphere.* The cognitive dimensions of the Mediterranean agrosystem are revealed in an explicit, didactic literature represented by agronomic works that span some 2500 years (Butzer 1993b, 1994). The concept of "good husbandry" pervades such Graeco-Roman, medieval, and Islamic writings, not as an ideology, but as a matter of economic rationale and proper civic behavior. Judgement is best based on an assessment of performance (Tuan 1968), rather than on simplistic, deductive inferences.

It requires no emphasis that these concluding observations represent testable hypotheses that can be reformulated to match other regional and diachronic contexts, and fall well within the interests of many archaeologists. This is where I see the productive intersection between archaeology and ecology in the long run. Archaeologists are uniquely equipped to document and model not only long-term settlement and land-use histories, but also to place these in the broader intellectual perspective they deserve.

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