

The influence of prehistoric Anasazi cobble-mulch agricultural features on northern Rio Grande landscapes

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Abstract.-Research concerning ancient Pueblo Indian farming, specifically the innovation of cobble-mulch gardens, suggests a manipulation of the local environment on a landscape level that helped create existing ecosystems. This agricultural technology, which consisted of a protective layer of gravel covering the productive soil, trapped seasonal runoff moisture in field areas, retained it, and guarded against evaporation. These water trapping features are usually found on terraces and slopes above riparian areas. The effect of this lithic-mulch technology on available water, drainage patterns, and general system dynamics is explored.

INTRODUCTION

Anthropogenic, or humanly created, landscapes cover the earth. Using differing technologies, cultures have dramatically altered riparian areas throughout history. Water being by biological necessity the main attraction, riparian areas abound with game and plants used for food, medicine, and shelter. Stream side areas and the resources associated with them have been utilized by people across North America for at least the past 12,000 years.

Studying the dynamics involved in the development of specific human landscapes is essential to understanding the active human role in the evolution of North American ecosystems. My purpose here is briefly to discuss a system of land and water use employed by the Rio Grande Anasazi that contributed to the cumulative development of contemporary landscapes, involving possible

lasting effects to riparian areas. The cumulative effect of the ancient farming techniques, including cobble-mulch gardens, may have been as influential in shaping existing landscapes as modern riparian usage. By clearing land for agriculture, constructing fields and water control structures, collecting wood for fuel and construction, and asserting selective pressures on local vegetation and animal populations, the Anasazi helped to create today's ecosystem conditions. As a result, these cumulative anthropogenic landscapes include lower stream channels and riparian areas, various aspects of alluvial terraces, talus slopes, and mesas. The landscapes and ecosystems we presently observe in many northern Rio Grande tributary valleys were altered by a pattern of prehistoric and historic human manipulation, extensive use, and abandonment.

COBBLE MULCH AS AN AGRICULTURAL TECHNIQUE

Gardens constructed with surface mulches that utilized pebbles, cobbles, and other lithic materials, were uniquely suited to the constraints of dry land

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environments. Use of cobble-mulch augments, traps, and retains available runoff moisture, elevates nighttime temperatures, and decreases soil erosion. Placement of lithic material on the surface elevates soil moisture retention by increasing infiltration and reducing the evaporative loss of water from wind and sun. By controlling weeds and raising soil temperature, mulching advances germination, growth, and maturation of crops (Lightfoot 1994:172). Stone mulch protects the soil surface from raindrop impact and runoff, further curtailing erosion, and inhibits salinization as the evaporation of salt-laden water at the soil surface is dramatically reduced (Lightfoot 1994:172). Lithic mulch also contributes to a better-distributed, deeper root system, improving drought tolerance.

Cobble-mulch distribution and history

Cobble-mulch agricultural methods have been used for more than two thousand years in both the Old World and the New World. The most ancient lithic-mulch plots are associated with ancient Nabatean sites in the Negev of southern Israel, where thousands of stone features were used between 200 B.C. and A.D. 600 (Kedar 1957; Lightfoot 1994; Issar 1995). In Italy and other regions of the Mediterranean, Roman agriculturalists produced grapes and olives using cobble mounds between 100 B.C. and A.D. 400 (Lightfoot 1994). Cobble-mulch features were used on the arid island of Lanzarote in the Canary Islands, near river channels in the Lanzhou area of central China, in the Atacama Desert of Peru, in northwestern Argentina, and in New Zealand (Lightfoot 1994).

In the American southwest, the Hohokam used as many as 42,000 rock mounds to grow agave in the Phoenix-Tucson region of southern Arizona between A.D. 850 and A.D. 1300 (Fish et al. 1990; Lightfoot 1994). Ridges of ash, cinder mounds, and rock piles, collectively covering an area greater than four hectares, were used by the Sinagua people between A.D. 1150 and A.D. 1250 for growing crops in the volcanic Sunset Crater region northeast of Flagstaff, Arizona (Berlin et al. 1990; Lightfoot 1994).

Northern New Mexico also contains hundreds of hectares of land altered by cobble-mulch gardens covering terrace and mesa tops around Anasazi pueblo sites, most built and abandoned in

the century between 1350 and 1450 (Cordell 1984; Anschuetz [In press b.]; Lightfoot 1993 and 1994). Such gardens may be found in the lower Chama, Rio del Oso, and Ojo Caliente valleys north of Santa Fe, though use and distribution may have been limited. Once believed to have been the stone foundations of pueblo dwellings, the function of these structures as gardens has been confirmed by the repeated recovery of maize and native cotton pollen in soil samples and from the discovery of stone cultivation tools on pebble-mulch gardens in the Galisteo Basin and the Rio del Oso (Lightfoot 1993 and 1994; Anschuetz [In press b.]).

Puebloan agriculture and cobble-mulch gardens

In much of the Anasazi Southwest after A.D. 900, domestic crops provided most of the nutritional requirements of the people. Considerable labor was expended to ensure agricultural success (Cordell, 1984). Prehistoric Puebloans manipulated their environments to produce corn and other crops within a wide variety of challenging settings and climatic conditions. Through a combination of strategies involving seed selection, fallowing fields, planting in different locations, staggering the time of plantings, and maintaining separate plantings of different corn and bean varieties, the problems of deficient moisture and short growing seasons were diminished (Lightfoot 1993).

The settlement of the upper Rio Grande region by Anasazi peoples appears to have occurred approximately between A.D. 1200 and 1500 (Cordell 1984; Anschuetz [in press b.]). Greater population densities, and increased social and economic pressures, were among the forces that may have pushed groups of ancient farmers into upland areas during the later part of the twelfth century A.D. By the late 1200s, Anasazi peoples had settled many Rio Grande tributary drainages (Cordell 1984). The Galisteo basin, Rio Chama, and Rio del Oso were inhabited and used to varying degrees during this time, although the sizes of pueblos and populations remained small (Lightfoot 1993; Anschuetz [In press b.]). By the early 1300s, referred to as the Pueblo IV period, the environmental conditions of the San Juan Basin in the Four Corners region had become increasingly arid and less predictable. The northern Rio Grande

and its tributaries represented a favorable alternative for agriculture and settlement (Cordell 1984; Fish et al. 1994).

Coinciding with the fourteenth century abandonments in the Four Corners region, increased immigration of Anasazi people to the northern Rio Grande appears to have taken place. The archaeological record of this period suggests that small villages were abandoned as people aggregated to larger settlements (Cordell 1984; Fish et al. 1994). These agricultural Puebloan groups settled many of the narrow drainage systems in the upper reaches of the Rio Grande, as demonstrated by the construction of large pueblo villages with sustained year-round occupation. Substantial multi-storied communities were established throughout much of the northern Rio Grande by the first half of the fourteenth century (cf. Wendorf and Reed 1955 in Cordell 1984; Anschuetz [in press b.]). This dramatic change in population distribution is exemplified in the Galisteo Basin where eight major Puebloan towns were established by 1350, each containing 1,000 to 3,000 rooms (Lightfoot 1993).

This apparent explosion in population and building, from the early fourteenth century into the early fifteenth, required greatly intensified and expanded agricultural production to support it. Subsistence risk was spread to ensure acceptable levels of harvest by using a variety of agricultural technologies, each adapted to the conditions of specific micro-environments or situations. Puebloan people in the northern Rio Grande during the fourteenth and fifteenth centuries utilized flood water irrigation, diversion dams, head gates, canals and ditches, in conjunction with floodplain fields, runoff fields, check dams, terraces, bordered gardens, and pebble-mulch gardens. With few exceptions these last structures were fabricated from in situ lithic materials, usually with stones or gravel found on or immediately below the surface of the ground. Stones were most frequently piled as mounds or in solid layers. Anasazi farmers made adjustments for seasonal variation by diversifying the location of fields (Woolsey 1980; Lightfoot 1993). The systematic use of such a variety of water harvesting and conservation techniques ensured that even marginally available water was not wasted. All these methods, including cobble-mulch gardening, allowed an-

cient farmers to expand arable land into areas previously considered less suitable for agriculture, and buffer their crops against inevitable drought (Anshuetz [In press a.]; Lightfoot 1993 and 1994).

STRUCTURE AND FUNCTION OF COBBLE-MULCH GARDENS

In 1994, White, Loftin, and Aguilar conducted a systematic analysis of cobble gardens located on Ojo Caliente river terraces, providing a vital understanding of the structure and general ecology of these agricultural features. Their work concluded that the gardens were usually constructed on Pleistocene fluvial cobble terraces, with sandy A horizons. This aspect is important, “. . . because (1) it would allow rapid infiltration of water and (2) a larger proportion of soil water can be extracted from sandy soils than from soils with greater clay content. Thus, rain could rapidly infiltrate and a high proportion is available to plants” (White et al. 1995: 16).

The researchers found that all of the cobble gardens tested were constructed on terraces with argillic B soil horizons. These argillic horizons function to retain water within the upper soil, thereby acting as a barrier to moisture loss. A similar effect occurs with the presence of a caliche horizon (White et al. 1995:17). Studies of ancient terrace farming features in the Mimbres area of New Mexico also suggest that a layer of impermeable caliche retains enough moisture for successful farming in arid conditions when using such techniques (Sandor et al. 1990).

Cobble-mulch gardens would have produced a more favorable agricultural environment for prehistoric farmers, and continue to support a greater cover of native plants on the garden plots than on surrounding areas (White et al. 1995:17). The presence of cryptogamic crusts verifies greater water retention (White et al. 1995), and according to Loftin and White (personal conversation, 1995) appears to contribute significant amounts of nitrogen to the soil. This concentration is highest in the upper horizons within the gardens, and would have acted to replenish soil fertility during fallow periods.

Currently, old cobble-mulch gardens continue to stabilize soil surfaces and protect the cryptogamic

crusts and other plants from root damage caused by grazing animals. "As a result, cobble mulch gardens presently function as islands of refuge for local vegetation (and perhaps associated fauna). Such refugia act as a source of seeds and genetic material to enhance the present rate of recovery of disturbed grasslands" (White et al. 1995:19).

The placement of cobble fields on slopes and terraces above drainages and riparian areas likely made the plots less susceptible to frost due to cold drainage qualities (Sandor et al. 1990; Anschuetz [in press b.]; Lightfoot 1994). Hydrologists have shown that small watersheds have a greater frequency of runoff events and increased runoff yield per unit area in arid regions than one would assume (Petersen and Matthews 1987:12-13; Lightfoot 1994). The runoff farming method used in the Negev Desert of Israel is a well-documented example of this hydrologic knowledge used in ancient agriculture (Evenari et al. 1961; Issar 1995).

ANTHROPOGENIC LANDSCAPES AND RIPARIAN AREAS

Within a landscape context, the structural and functional qualities of cobble-mulch gardens should be viewed as integral components within a larger system of water and land manipulation. As noted above, prehistoric agriculture had significant long-term impacts on the landscapes and ecosystems of North America (Denevan 1992; Doolittle 1992; Whitmore and Turner 1992). To truly appreciate this scale of impact and change, the entire system of land use needs to be examined.

The approach in this study employs the concept that the distribution of archaeological artifacts and features in relation to elements of the landscape provides insight into past social and economic systems. By focusing on land use, potentially synergistic connections among ecosystems, landscape physiography, and the spatial aspects of human environmental manipulation may be investigated. This archaeological inquiry into past land use through a landscape perspective combines the use of regional geomorphology with study of taphonomy, formation process, and ethnoarchaeology (Rossignol 1992:4). Past cultural landscapes cannot be observed or described directly, as their composition, structure and develop-

ment must be reconstructed from available paleoecological and archaeological evidence. The ecology, function, and maintenance of a cultural landscape through time must be inferred through such reconstructions (Birks et al. 1988). As Crumley and Marquardt have noted, "Landscapes are real-world phenomena. In interacting with their physical environments, people project culture onto nature" (1990:73).

The overall human impact on an ecosystem is interrupted by periods of reversal and a degree of ecological rehabilitation as systems fail, populations decline, and habitats are abandoned. Environmental impacts may be constructive, benign, or degenerative, but change is continual, occurs at variable rates, and proceeds in different directions. Even mild impacts and slow changes accumulate, and long-term effects can be dramatic (Denevan 1992:381).

The Rio del Oso drainage, a tributary of the Rio Chama, is a compelling example of a landscape altered by Anasazi agricultural practices. From 1992 through 1994, Kurt Anschuetz, with the University of Michigan Museum of Anthropology, conducted extensive study of the Rio del Oso, showing that this tributary drainage of the Rio Grande was densely settled by Pueblo Indian groups between ca. 1200 and 1500. The team recorded 271 archaeological sites, ranging in age from the late Archaic period (before A.D. 400) to the middle of the nineteenth century (Anschuetz [in press a. and b.]).

Analysis of the archaeological record suggests that the Rio del Oso valley was most intensively occupied during the thirteenth and fourteenth centuries. Anschuetz's survey team found Pleistocene terraces associated with five prominent mesas located on the north side of the valley, covered with hundreds of technologically diverse prehistoric agricultural features. Opposite the mesas and fields are the ruins of four aggregated multi-storied pueblo villages (Ku, Te'ewi, Pesedeuinge and Maestas pueblos). Few agricultural features have been found on the south side of the valley, perhaps due to poor soils and lack of adequate solar exposure (Anschuetz [in press a. and b.]). It appears that between 1450 and 1500, the valley was essentially abandoned with only periodic farming, perhaps when conditions were favorable.

I have chosen to view the past of the Rio del Oso area as a series of temporally grouped anthropogenic landscape layers, rather than analyzing individual sites. Placing the Anasazi occupation of A.D. 1200 to A.D. 1500 within a tangible temporal context is important. Thousands of years of hunter gatherer land use likely had a significant, though different, impact on this landscape from that created by Puebloan peoples. Each period of land use in the valley contains a unique set of landscape altering dynamics, and the preceding occupations provided a base for the next stage. In essence, this landscape has passed through a process of differentially intensified domestications.

The reconfigured landscapes resulted from combined and cumulative settlement, and were not just the result of one culture's agroecological landscape replacing another's (Doolittle 1992). These dynamic historical processes created "hybrid" landscapes (Whitmore and Turner 1992). The Puebloans landscape was not replaced by a Spanish ranching landscape created by livestock grazing and road building; rather, the latter system was built upon the former. A landscape ecosystem never returned to its "natural" condition, but it was transformed by subsequent human processes. Anthropogenic transformation of the land took place as people

"...engineered nature into regional mosaics comprised of diverse systems of cultivation which contributed to extensive land modification and conversion. The particular systems and the landscapes in which they were imbedded were the result of real and perceived needs in the context of the cultural and environmental constraints and opportunities" (Whitmore and Turner 1992:419).

Puebloan cobble-mulch gardens and the water harvesting features associated with them would have augmented the effects created by clearing the land for agriculture (fig. 1). Runoff was controlled, directed, and then retained within the soil of the garden plots. The plots received direct rain, runoff moisture, and snowmelt before it could flow off the mesas and mid level terraces to the riparian areas below. The stone agricultural features essentially functioned as reservoirs. Less water would subsequently have reached riparian areas, and this in turn would have affected vegetation as well as the hydrological dynamics of the system (fig.2-3). By controlling runoff and erosion, the physiography of the landscape was likely maintained and

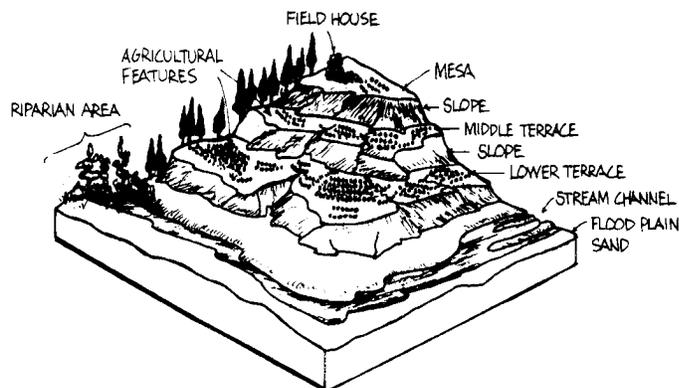


Figure 1. Landscape with cobble-mulch gardens.

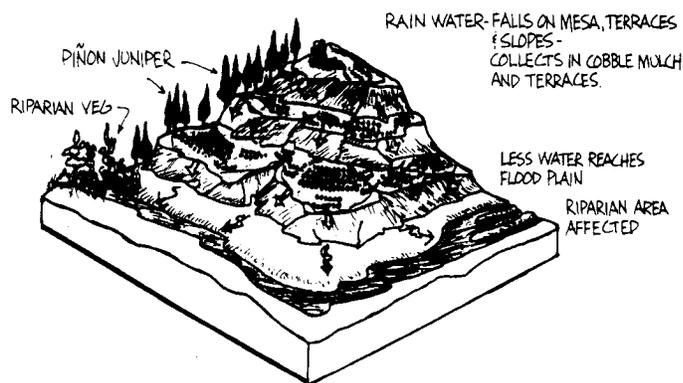


Figure 2. Runoff and cobble-mulch landscape.

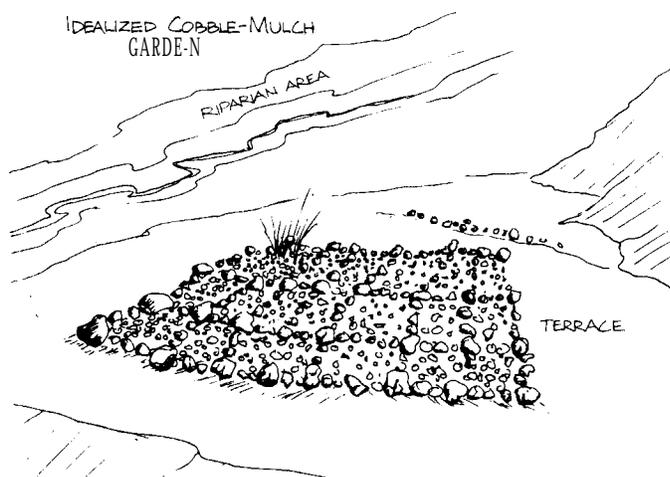


Figure 3. Reconstructed cobble-mulch plot.

sediment loading decreased. Although Anasazi crops no longer grow on the cobble-mulch fields, the water conserving mulch remains in place, stimulating more vigorous plant growth in the native short grasses on the gardens rather than off the gardens on non-mulched soil. This difference in plant density and vigor is remarkably visible in color infrared photographs of the Galisteo Basin taken by NASA's Stennis Space Center in September 1987. Through subsequent analysis of the photographs and follow up field surveys, Lightfoot was able to identify 96 previously unrecorded cobble-mulch gardens (Lightfoot 1993:116).

Research conducted by White and his colleagues supports the premise that these remnant agricultural landscape features persist in affecting ecosystems hundreds of years after abandonment (White et al. 1995). If this idea of continuing influence on the landscape is extended, a pattern of cumulative

or increased ecological effect may be discerned (fig. 4). Considering that 50% of the total terrace area along the Rio Ojo Caliente is covered with cobble-mulch gardens and other agricultural features (White and Loftin, personal conversation, 1995), the overall influence of the anthropogenic landscape components becomes significant.

CONCLUSION

Ancient agricultural landscapes contain an abundance of evidence relating to the development and adaptation of agricultural systems, specific crop and soil management techniques, and the effects of agricultural land use on the physical environment. The archaeological record provides a necessary long-term view of land use, which is crucial to the development of sustainable agricul-

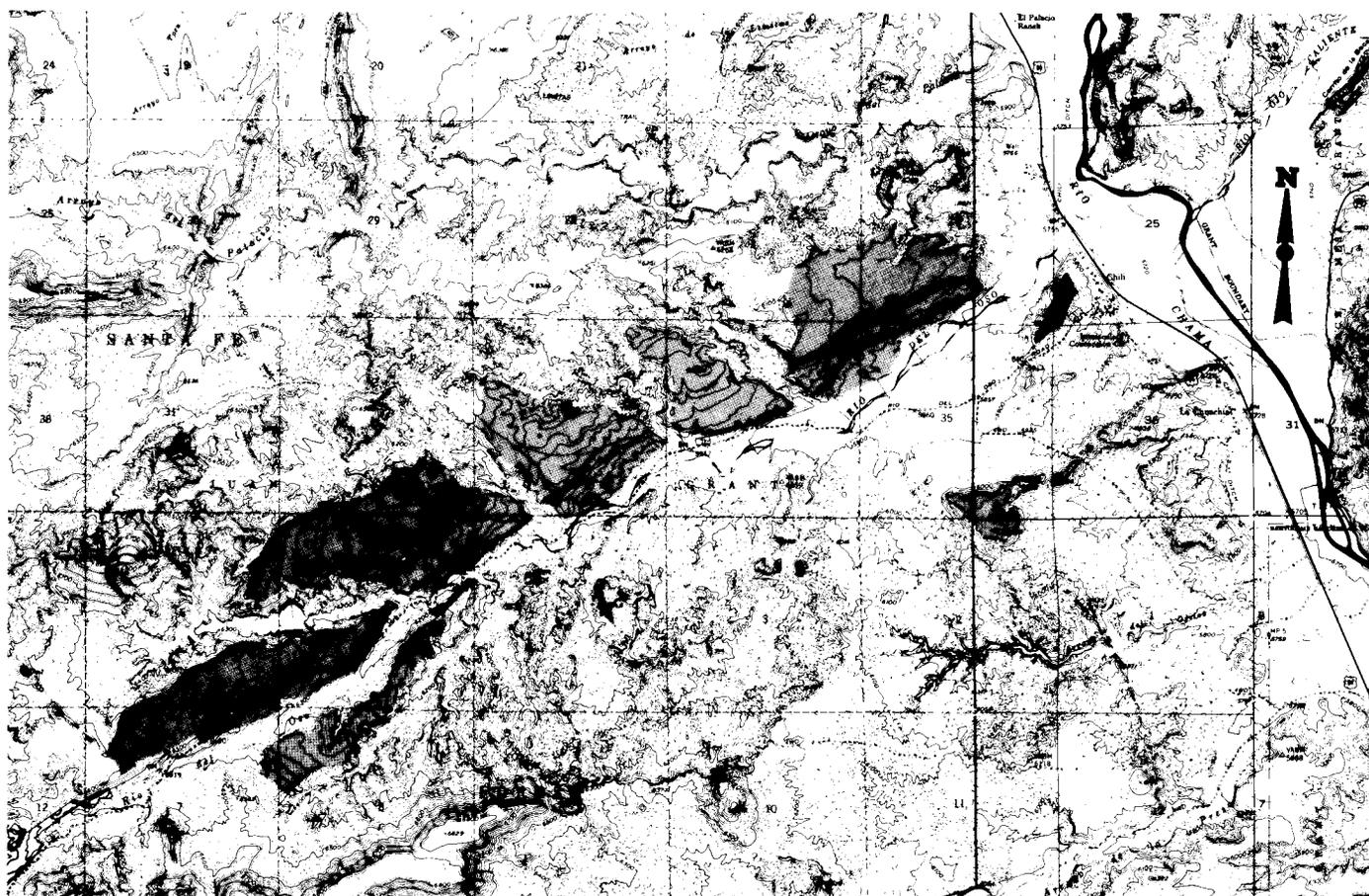


Figure 4. Agricultural landscape areas in the Rio del Oso.

tural systems that are productive and protective of soil and other natural resources (Brooks and Johannes 1990; Sandor et al. 1990).

Ancient peoples resourcefully and creatively adapted to environmental, climatic, and cultural challenges throughout their resilient 12,000 + year tenure on this continent. This intimate relationship with the landscape has played a vital and dynamic role in the evolution of ecosystems throughout the hemisphere. Future research will include a simulated reconstructive modeling of the Rio del Oso landscape, built upon data gained from a cross-sectional series of pollen and micro-charcoal cores. By studying ancient agricultural landscapes including cobble-mulch gardens, and through subsequent research of other landscape-shaping anthropogenic systems, we will be better able to understand this interaction and its continuing effects on today's ecosystems.

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