HOHOKAM POLITICAL ECOLOGY AND VULNERABILITY: COMMENTS ON WATERS AND RAVESLOOT

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Waters and Ravesloot (2001) test the assumption that natural river channel change caused periods of Hohokam cultural reorganization. However, they conclude that channel changes did not correlate with all periods and areas of significant cultural changes and that landscape alone cannot explain Hohokam transformations. An anthropological perspective on political ecology and disasters can explain why environmental processes and events differentially impact societies, differentially impact societies diachronically and differentially impact social groups within societies. We suggest that this perspective may explain the variability described by Waters and Ravesloot.

Waters y Ravesloot (2001) examinan la presunción de que los cambios de los canales naturales de los ríos pueden haber causado periodos de reorganización cultural de los Hohokam. Sin embargo, concluyen que los cambios en los canales no se correlacionan con todos los periodos y áreas que sufrieron cambios culturales significativos y que solo el paisaje no puede explicar las transformaciones de los Hohokam. Una perspectiva antropológica sobre ecología política y el estudio de los desastres explica por qué los sucesos y procesos medioambientales tienen un impacto diferenciado en distintas sociedades, afectan de forma distinta a las sociedades diacrónicamente, y tienen un impacto diferente en distintos grupos sociales dentro de las mismas sociedades. Sugerimos que esta perspectiva puede explicar la variabilidad descrita por Waters y Ravesloot.

In a recent paper, Waters and Ravesloot (2001) examine the relationship between landscape changes and evolutionary shifts in Hohokam culture. Landscape change, in this instance, refers to river channel downcutting, widening, braiding, and filling during periods of climatological instability. Environmentally caused landscape change is established as a possible "mechanism" for cultural change.

Waters and Ravesloot test this possibility by correlating changes in river channels with periods of cultural reorganization among the Hohokam. The Hohokam are viewed as being dependent upon irrigation agriculture, which made their food production system susceptible to changes in river channels. Waters and Ravesloot are not alone in suspecting that floods influenced prehispanic and historic society in the Phoenix Basin. Dendrochronological data originally suggested this possibility, and since Graybill's (1989), and Nials et al.'s (1989) studies there has been much attention to climate and canal sedimentation records for this reason. However, others argue that flood-associated damage to canal headgates was relatively easy to repair unless damage extended down the canal (Huckleberry 1999:8) or that floods were relatively ephemeral events having little impact on Hohokam society (e.g., Dean et al. 1994:57). Similarly, Masse (1991:219) states that the destruction of irrigation systems is not a sufficient explanation for abandonments at the end of the Classic period. However, Waters and Ravesloot's focus on river landscape change adds an important dimension to this debate.

According to Waters and Ravesloot, Hohokam culture initiated and flourished because there were stable channels with periodic flooding creating "excellent conditions for the establishment of canal systems and the development of Hohokam culture" (Waters and Ravesloot 2001:290). In the Sacaton phase (A.D. 950–1150) of the Late Formative period,

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Hohokam settlements and ballcourt villages reached their maximum extent and many villages reached their maximum size and complexity as floodplain deposits continued to build vertically (Waters and Ravesloot 2001:291). According to Waters and Ravesloot (2001:291–292), there was a major change in the Middle Gila River floodplain occurring between A.D. 1020 and 1160. The channel was subject to downcutting and widening. This period also was marked by intensified high-magnitude flooding (Waters and Ravesloot 2001:292). According to Waters and Ravesloot (2001), these environmental changes made it difficult for Hohokam farmers to manage their canal intake structures located in the river channels. They claim the resulting cultural changes at the beginning of the Classic period included abandonment of some villages, shifts toward new architectural forms, shifts from cremation burials to inhumations, partial replacement of previous pottery types, changes in exchange patterns, the collapse of the ballcourt system and the emergence of platform mound architecture. They claim the canal systems were consolidated into "irrigation communities" (hierarchically arranged settlements along each canal network) in the Classic period and irrigation farming was supplemented with dry and floodwater farming on bajadas (Waters and Ravesloot 2001:291). "The Classic period Hohokam responded to fluvial instability by pooling their resources and organizing their labor, reengineering their canals, placing canal heads in stable positions, and increasing and diversifying food production by pursuing dry and floodwater farming" (Waters and Ravesloot 2001:292). River floodplains became stable again between A.D. 1300 and 1400. At the end of the Classic period (ca. A.D. 1450), villages were abandoned and Hohokam culture ended. Although no major landscape changes occurred at the end of the Classic period in the Middle Gila River, Lower Salt River, and Tonto Creek, arroyo cutting did take place in the Santa Cruz and San Pedro rivers.[1]

Waters and Ravesloot use a period of hardship among the late nineteenth-century Akimel O'odham as an analogy to the effects of channel instability on the Hohokam. The Gila River channel widened and frequent flooding caused the destruction of canal headgates. They claim "the situation became so critical that Akimel O'odham were malnourished as a consequence of repeated crop failures" (Waters and Ravesloot 2001:292).

Waters and Ravesloot conclude their paper by stating that changes in river landscapes were factors in cultural reorganization at the beginning of the Classic period but not at the end of the Classic period when the most dramatic changes in Hohokam cultural history occurred (except in the Tucson Basin and Lower San Pedro Valley). They found that the environmental deterministic approach they entertain could not explain why landscape change correlates with cultural change at certain times and places, but not at others, except to state that landscape is one factor that should be considered. However, brief statements in their abstract and conclusions suggest an awareness that cultural trends were also major factors: "As shown, a regional episode of channel erosion appears to have contributed to social, political, economic, and demographic changes seen in the Hohokam culture area between ca. A.D. 1050 to 1150 *by accelerating cultural changes that were already underway*" (Waters and Ravesloot 2001:296; emphasis added). Here, we suggest that an anthropological perspective on political ecology and vulnerability to disasters may help to explain some of the differential impacts of floods and river channel changes reported by Waters and Ravesloot.

Political Ecology and Disaster Vulnerability

Since the 1970s the growth of political ecological perspectives and hazards perspectives in the social sciences has led many scholars in those disciplines to consider disasters less as the result of geophysical extremes such as floods, droughts, earthquakes, or hurricanes and more as functions of social conditions (e.g., Alexander 1997:28; Bassett 1988; Blaikie et al. 1994; Hewitt 1983; Lees and Bates 1990; Schmink and Wood 1987; Stonich 1993; Susman et al. 1983; Toledo 1989; Wisner 1976, 1978; Wolf 1972). "It is now widely recognized that 'natural disaster' is a convenienced term that amounts to a misnomer" (Alexander 1997:28). This approach focuses on the effectiveness of societal adaptation to the total environment, including the natural, modified and constructed milieu of which the community is a part (Hewitt 1983).

Political ecology is based on the premise that political, social, and economic considerations mediate the dynamic interactions between humans and their environment. This perspective integrates political economy and human ecology by exploring the connections between the current and historical influences of the

natural environment on human groups and the impact of larger political and economic forces that characterize the society of which the people are members (Cambell 1996:6). For instance, Watts (1983) views famine as an economic, social, and environmental phenomenon and suggests that analyzing famine also "demands a careful deconstruction of the social, political, and economic structure of the society so afflicted and of its historically specific systems of production" (Watts 1983:19). Human-environmental relations, key to the evolution of disasters, are always mediated by the social relations through which the members of a society interact with their surroundings (López 1999). By adopting a political-ecological approach to the study of disasters, anthropologists focus their attention on "the dynamic relationships between a human population, its socially generated and politically enforced productive and allocative patterns and its physical environment, all in the formation of patterns of vulnerability and response to disaster" (Oliver-Smith 1998:189). These social relations are maintained by the dominant forms of production in a process that determines the patterns of resource allocation and other forms of social, political, and economic differentiation. This differentiation, in turn, privileges some individuals and groups with enhanced security, while subjecting others to systemic risks and hazards (Blaikie et al. 1994:24; López 1999; Oliver-Smith 1998:189).

The concept of vulnerability is a fundamental element to the political ecology of disasters; it has been developed in the last decade as an alternative, or a complement, to the previously dominant "hazards paradigm," which focused exclusively on the environmental hazards themselves (Blaikie et al. 1994:218). The vulnerability approach, on the other hand, focuses upon who is affected and their ability to withstand, mitigate, and recover from the damage caused by disasters and other crises; this strategy underscores the importance of the socioeconomic order and the ecological relations of life in particular places. The concepts of vulnerability and risk recognize the important extent to which the likelihood of disaster depends upon the social order, its everyday relations to the environment, as well as the larger historical circumstances that shape people's environments (Alexander 1997:291; Hewitt 1997:141). Generally, costs and benefits are unequally distributed among individuals and groups, reflecting existing social and economic inequalities. Moreover, the differentiated social and economic impact of environmental change also has political implications in that the relative power of some actors in relation to others influences the impact that the event has on them. It follows that people's economic and political positions in society determine their vulnerability to disasters and environmental crises (Bryant and Bailey 1997:28–29).

Recent anthropological analyses of cultural change among the Honduran population after Hurricane Mitch in 1998 stress the interrelated sociopolitical, economic, and ecological dimensions of disaster. Olivo's study of cultural change in a disaster-stricken community (2002; López 1999) demonstrates linkages among a highly vulnerable economy, unequal distribution of resources, widespread food insecurity and severe environmental degradation that characterized Honduras prior to the disaster, on the one hand, and the implementation of resettlement and reconstruction, gender-differentiated vulnerability, and changes in local livelihood strategies and social and gender roles on the other. De Vries's (2000) research on post-flood adaptation among subsistence-based riverine communities in Moskitia relates their historically patterned vulnerability with cultural resiliency and adaptive livelihood strategies as elements in dynamic interaction with extreme ecological destabilization conditions and the contested process of reconstruction. These and other studies (e.g., Bolin and Stanford 1999; Lees and Bates 1990; Moore 1993; Oliver-Smith 1999; Sen 1981; Stonich 1993; Torry 1986a, 1986b) have addressed the social construction of vulnerability, stressing the interrelated sociopolitical, economic, and environmental dimensions of disasters and are examples of an alternative disaster research agenda that emphasizes the need to work simultaneously on political economic and environmental dimensions.

Although undeniably providing critical information on disasters in prehistory, early attempts by archaeologists to rely solely on physical sciences diverted attention away from the historical conditions promoting disasters as studied in anthropology today (Van Buren 2001:143). Archaeologists have more recently found the concepts of disaster resilience and vulnerability useful for explaining differential impacts on societies. Sheets's (1999) study of volcanic eruptions in Central America concludes that some societies were more resilient to these calamities while others were more vulnerable, resulting in regional abandonments. In one volume dedicated to

the study of disasters and human response (Bawden and Reycraft 2000), authors sought to identify how far patterns of response were dependent upon social organizational complexity, geographic context, range of subsistence resources, cultural configuration, and the intensity and range of the environmental disruption (Reycraft and Bawden 2000:3). Two examples from that volume include Zarins's (2000) conclusion that tribal societies were more resilient to repeated typhoon storms than were city-states in southern Arabia and Santley et al.'s (2000) suggestion that different social variables in southern Veracruz, México, influenced abandonments after volcanic eruptions in the Preclassic period but not in the Classic period.

Historical Analogy: The Akimel O'odham

Like Waters and Ravesloot, we believe that historical analogy with the Akimel O'odham is appropriate for viewing how river channel changes could have impacted the Hohokam. On the other hand, numerous authors have documented the political-economic and political-ecological factors that adversely affected the Akimel O'odham and neighboring aboriginal populations in south-central Arizona. In this section, we summarize the historical information on the Akimel O'odham that suggest the natural floods and associated landscape changes should not be viewed apart from social factors.[2]

The Late Nineteenth-Century Akimel O'odham

According to Waters and Ravesloot (2001:293), "the period of channel downcutting and widening documented on the middle Gila River in the late nineteenth century decimated the traditional farming lifeway of the Akimel O'odham" (citing Rea 1997). However, the 1870–1910 "years of famine" (Ezell 1983:158–159) among the Akimel O'odham occurred within the context of increased Anglo settlement within the region and competition for land and river water. As early as the 1840s the Akimel O'odham were already marketing beef and wheat to nonaboriginal groups in the area (Ezell 1983: 155–156). Following the Mexican-American War (1846–1848), and the Gadsden Purchase, there were American takeovers of some Akimel O'odham homelands (Barnes 1984; Weber 1982). The nineteenth-century Pee Posh (Maricopa) and Akimel O'odham were targets of frequent Apache raids (Ezell 1983), which may have begun in the eighteenth century. Prompted by federal parcel sales to land speculators, grants to companies and veterans, and the General Homestead Act (1862), thousands of Anglos and other nonaboriginal groups settled in the Phoenix Basin in the years following the American Civil War (Sheridan 2001:143). Epidemics caused rapid population loss (Meister 1975:119, 129; Spicer 1962:149). Changing internal social relations are exemplified by leadership shifting from persons of power without wealth to an emphasis on wealth (Hackenberg 1983:161). Additionally, Anglo farmers upriver from the Akimel O'odham diverted Gila River water, "wasting water instead of returning it to the Gila" (Ezell 1983:158), making it extremely difficult for the Akimel O'odham to irrigate their farmlands. According to Ezell (1983:158), the only reason for not ejecting the Akimel O'odham and Pee Posh altogether was due to Anglo fears of potential large numbers of indigenous warriors.

Many Akimel O'odham and Pee Posh did have to leave their homes and settle along the Salt River upstream from the Anglo and Mexican settlements. The Pee Posh, who were concentrated near the confluence of the Salt and Gila rivers, did not regain rights to Salt River irrigation water until 1903 when they demonstrated prior aboriginal Salt River irrigation of those lands (Hackenberg and Fontana 1974:54–55). Several other Akimel O'odham and Pee Posh irrigation systems were finally established around the turn of the century (e.g., Doyel and Ensor 1997:9–10; Ensor and Doyel 1998; Gregory and Huckleberry 1994). With the loss of much prime irrigable land, loss of river water to irrigate what land remained to them, pressures to acculturate, unfavorable market and labor relations, endemic warfare, and shifting of alliances, environmental change was clearly not the major factor resulting in the late nineteenth-century hardships. Nevertheless, there was a period of unprecedented channel widening and floods *in addition* to these political economic problems. However, the landscape changes themselves were also not independent of social factors.

Human Influence on the Gila River Channel

Waters and Ravesloot acknowledge that human impacts contributed to the late nineteenth-century channel changes to the Gila River. Dobyns (1981) critiques the perspective that the historical erosion and arroyo cutting along the rivers of the Sonoran Desert are merely "natural" phenomena. He outlines

the historical land-use changes occurring along the rivers to conclude that the nineteenth-century erosion involved a combination of factors. In the late nineteenth century, accelerated desertification occurred from the tremendous increase in cattle grazing among Anglos, Mexicans, and aboriginal populations. Similarly, Bahre (1991) emphasizes that human impact from livestock grazing, wildfires, fuelwood cutting, exotic plant introductions, groundwater pumping, logging, and wild hay harvesting have caused environmental degradation since the 1870s. Although the Desert Land Act (1877) and the Stock-raising Homestead Act (1916) enlarged the size of property allotments, ranching tracts remained inadequate to thwart degradation from overgrazing and land compaction (Sheridan 2001:143). Adding to homesteaders' herds, southern Plains droughts (1883–1884) and severe blizzards in the Dakotas (1886–1887) instigated enormous livestock transfers to other ranges including Arizona. The estimated 38,000 head of cattle that roamed the Arizona Territory in 1870 surged to about 1.5 million cattle and more than one million sheep by the early 1890s (Sheridan 2001:143). To make matters worse, some floodplain areas were completely stripped of mesquite (a source of food and floodplain stability) to fuel steam flour mills (Hackenberg 1983:171). Wheat became an important cash crop. Plow cultivation of large tracts of floodplain areas devastated natural vegetation that ordinarily prevented erosion (Graf 1988:251). Failed attempts by nonaboriginal groups to irrigate led to "stream channel erosion that lowered the surface water and with it the subsurface water table, drying up springs and markedly altering valley bottom vegetation" (Dobyns 1981:57). In one failed attempt by the South Gila Canal Company in 1890 to develop land with irrigation features "a single flood produced by errors in watershed management above the Lower Gila River oasis created an eroded channel at least six feet deep and evidently one mile wide!" (Dobyns 1981:75–76). A prolonged drought and sporadic floods from 1885 to the early 1900s, land degradation from deforestation to fuel mines and mills, livestock overgrazing and overpopulation, and nontraditional agriculture combined to produce what Moseley (1999) labels "*convergent catastrophe.*" It is easy to see how the Akimel O'odham and Pee Posh were highly vulnerable to disaster when the floods came.

Graf (1988:292) states that the modern construction of irrigation systems and "leveled" fields radically altered the inundation pattern of the Santa Cruz River resulting in destructive erosion and sedimentation. Although Huckleberry (1994) suggests that a 1983 flood produced by an eastern Pacific tropical storm was less damaging to the Gila River channel than a 1993 flood produced by a series of cold fronts from the northern Pacific, it also seems possible that increases in leveled field construction in the period between the two floods may have contributed to the greater impacts of the 1993 flood. However, these modern analogies may not be representative of prehistoric floods given the increased density of tamarisk (an exotic phreatophyte introduced to the Southwest) within the Gila River channel, which increased channel sinuosity since the 1950s and implies significant erosion of channel banks and increases overbank flooding (Graf 1988:252–253).

Hohokam Political Ecology and Disaster Vulnerability

In the case of the Hohokam, we find the data presented by Waters and Ravesloot interesting in that some periods and places of cultural transformation were accompanied by landscape changes while others were not. Dryland rivers certainly have natural geomorphological processes (e.g., Graf 1988), and a political-ecological approach may not explain all human-environment relations in prehistory. However, we wish to entertain three political-ecological hypotheses here that may help to explain the varying correlations between the landscape and cultural changes described by Waters and Ravesloot.

The first hypothesis is that the population growth, which may have peaked during the Sacaton phase (A.D. 950–1150) (Doyel 1980:33), and the expanding irrigation networks (Nicholas and Neitzel 1984) made the river channels more susceptible to erosion and downcutting triggered by flood events at A.D. 1020–1160. That is, the channel changes documented by Waters and Ravesloot were the results of anthropogenic conditioning factors with peak flood years acting as a catalyst. Other archaeologists working in the Phoenix Basin have concluded that landscape changes occurred from Hohokam settlement disturbance, irrigation, horticulture, and sediment salinization caused by irrigation in addition to selected encouragement of vegetation and small animal habitats (e.g., Anderson and Smith 1994; Bohrer 1991; Kwiatkowski 1994:33–34; Smith et al. 1995;

Szuter 1991). The ecological impacts from settlement disturbance and increased field areas may have increased the chance of erosion, triggered by floods (although crop and field-edge vegetation management may have buffered erosion).

Because flood-induced channel changes should affect most or all of a watershed, one possible means of testing the influence of anthropogenic processes could involve applying the same tests that Waters and Ravesloot apply for the Middle Gila River downstream from Hohokam irrigation communities to areas upstream from major irrigation communities. If upstream portions of the Gila River did not experience the degree of channel erosion and downcutting Waters and Ravesloot document for the downstream areas, there may be partial support for anthropogenic influences on channel changes. If, on the other hand, there is evidence for similar dramatic channel changes upstream from major Hohokam irrigation networks, then greater weight can be given to environmental causation.

The second hypothesis is that decreasing interaction between settlements resulted in competitive political relations between settlements and/or between irrigation communities, which influenced vulnerability to channel changes. The Late Formative period was a time of increased intersettlement interaction and population growth. Over 225 ballcourts were built throughout central and southern Arizona by the end of the Late Formative indicating an increase in the hosting of intersettlement collective public events as the context for marital alliances and exchange (Doyel 1991a:247; McGuire and Howard 1987:130; Wilcox and Sternberg 1983). Villages had planned circular, corporate layouts with open plazas (likely for hosting dances). Mortuary customs, especially those for individuals of high status, involved elaborate public cremation rituals, which also involved intersettlement interaction and planning (McGuire 1992:48). At some sites, large ceremonial structures capable of housing many people were constructed (e.g., Wilcox et al. 1981:182). Some villages had areas with numerous pits interpreted to represent public ceremonies (e.g., Bostwick and Downum 1994:322; Haury 1976:155–156; Wilcox et al. 1981:145). Throughout the Late Formative period, the hosting of intersettlement events necessitated surplus labor for feasts, dances, and nonutilitarian artifact production and exchange. Even figurines represent ballgames (Wilcox and Sternberg 1983) and cremation rites (Thomas and King 1985) illustrating the importance of communal events that involved regional interaction.

Interaction between settlements and irrigation communities declined during the Late Formative-Classic period transition. With few exceptions, ballcourts ceased to be used at the end of the Sacaton phase. Alongside this gradual change was the shift away from circular, corporate village planning with open central plazas (likely for hosting dances), cremation rituals that would have been public events and an end to other public ceremonies. Because ballcourt-related events, feasts, and other collective ceremonies were the contexts for intersettlement exchange and marital alliances, their abandonment has important implications for social relations.

In contrast to the interactive nature of Hohokam society in the Late Formative period, the transition into the Classic period witnessed the beginning of patterns suggesting irrigation network isolationism and interhousehold competition. By the early Classic, domestic compounds had their own ritual spaces surrounded by compound walls (Doyel 1991b:253; Sires 1987). The shift to inhumation burials, located adjacent to or within compounds, demonstrates a shift from the elaborate public planning of cremations to compound-focused ritual. Furthermore, there was far more investment in mortuary assemblages at all compounds than in the Late Formative period, illustrating competition between those domestic units. There are no indications of other public ceremonies. Even the platform mounds were surrounded by compounds (presumably elite residences), which were surrounded by large enclosing walls (e.g., Bostwick and Downum 1994:341–344; Crown 1991:151–152; Gregory 1987) for restricted access and privacy. Along with these shifts away from public interaction, Rice (1998) suggests that settlements within irrigation communities were competitive but that they formed alliances when competing with other irrigation communities. Van Keuren et al. (1997) show a decline in intersettlement exchange of pottery. Abbott (2000:170) also concludes through pottery analyses that there was less interaction between irrigation communities along the Salt River at the beginning of the Classic period. Many of the crafts that were widely circulated through intraregional exchange were no longer produced (Doyel 1991a:239) or were concentrated at platform mound sites (Bayman 1999:275). Local obsidian sources

could no longer be relied upon, and there was a shift toward acquiring obsidian from long-distance sources (Bayman and Shackley 1999). Possible evidence for conflict also correlates with this transition (e.g., Rice 2001; Wilcox and Haas 1994:231–232). Although the jury is still out as to whether or not the Hohokam were involved in warfare, such conditions should be expected to increase the vulnerability of populations involved, with or without landscape changes. There was also increased elite control over craft specialization and exchange in the Classic periods (McGuire and Howard 1987:137). Although canal system management was likely by elites in the Late Formative period, the Classic period distribution of platform mound sites along major canals implies increased elite control over water distribution (Dean 1987:260; Gregory 1987:209). Many of the changes that began in the Sacaton phase and characterize the Soho phase of the Early Classic period can be viewed as a shift from a religious base to a secular base (Doyel 1976, 1980:36, 1991a:239), from public corporate ritual to ostentatious privatized ritual, and from interaction between irrigation systems to isolationism.

Along the low-discharge Middle Gila River there was less consolidation of previous canal networks than occurred along the Lower Salt River (Crown 1987:158; Wilcox 1979:114). Along the Middle Gila, there was an increase in the numbers and sizes of upstream settlements while downstream there were abandonments of large settlements (including Snaketown), abandonments of smaller settlements, and only smaller settlements were founded (Wilcox 1979:106). These patterns suggest a situation of competition along the Gila River. Whether the social changes occurred as a response to the channel changes or were independent of the channel changes, the social competition along the Gila River in the Soho phase was not conducive to regional cooperation in environmental management. Instead, upstream large-scale irrigation communities would have diverted river water, making it less available to downriver irrigation communities. Not only would downstream settlements have to place canal headgates further into the river channel to capture water, the damage caused by otherwise normal floods would have been more severe than for the upriver communities. Interestingly, there was an increase in dry farming and water storage reservoirs in the Classic period, which may have provided marginalized groups with agricultural and other floral and faunal alternatives to irrigation crops (Bayman et al. 1997) during a period of decreased interaction. Thus, due to political ecological circumstances along the Gila River at the end of the Late Formative, different settlements were differentially vulnerable to floods.

Among the Salt River populations, on the other hand, many Late Formative settlements continued to flourish into the Classic period. In fact, major villages all along the Lower Salt River continued to increase in size (Wilcox 1979:114). There also was more consolidation of irrigation networks (Wilcox 1979:114; see also Nicholas and Neitzel 1984:161) demonstrating more cooperation in agriculture than among the Gila River communities. Whether one accepts the possibility that channel erosion and downcutting occurred from anthropogenic and increased flooding or that channel changes were purely environmental phenomena, the different social circumstances between the populations of the two rivers may suggest different patterns in resiliency and vulnerability.

To support or reject this hypothesis, more synthesis of new and existing research on political economy (e.g., interaction among settlements and irrigation communities) with political ecology (the effects of increasing population, irrigation agriculture, and other resource utilization on floodplain stability) is needed. Similarly, more recent settlement data along the Middle Gila River could contribute to our understanding of settlement growth and abandonment with which to test the model on differential vulnerability. Alternatively, the nature of the two rivers themselves may have conditioned different strategies. Crown (1987:158) points out that the southern portion of the Middle Gila River had a more narrow irrigable floodplain than that of the Lower Salt River. Could this factor have influenced less consolidation of irrigation communities, less interaction and competition for access to river water? Another factor that may suggest natural differences in channel change involves differences in sediments. The deeper Salt River cuts into a Pleistocene formation with gravels and dense caliche while the low discharge Gila River cuts into a fine particle Holocene floodplain (Phillips 1997:25–27). We would like to know if the Gila River channel was more susceptible to changes for this reason.

The third hypothesis is that commoners were disproportionately more vulnerable to environmental fluctuations than leaders, which may explain events

at the end of the Classic period. After the Classic period, Hohokam settlement was characterized by small villages and dispersed rancherias (Doyel 1991a, 1991b). We find it particularly interesting that Waters and Ravesloot found no evidence for river landscape changes along the Middle Gila River, Lower Salt River, and Tonto Creek that correlate with this dramatic period of change in Hohokam society. Nevertheless, some investigators have found paleoclimatological evidence for a prolonged drought followed by floods (e.g., Graybill 1989; Nials et al. 1989). This discrepancy may involve different types of data. Alternatively, those particular floods may not have seriously altered the river landscapes. Teague's (1993) discussion of O'odham oral histories describes an uprising against specific arrogant chiefs at specific sites following a drought and a flood at the end of the Classic period. Archaeological data support some of the specific accounts in the oral histories (Teague 1993). If the social relations left commoners in a disproportionately vulnerable position compared to chiefs, due to differential water and resource allocation between settlements (e.g., Crown 1987:157; Dean et al. 1994:57), a drought and flood may have exacerbated social tensions. On the other hand, the end of the Classic period could be related solely to social factors, which also deserves attention.

One possible means for testing differential vulnerability between commoners and elites is to compare osteological and dental evidence for biocultural stress (e.g., Powell 1988). For example, both commoner and elite cremations of the Late Formative period have been identified at Snaketown. Dental remains may be preserved for analysis. Similarly, we may assume that the Classic period inhumations adjacent to the platform mound at Pueblo Grande (Brunson-Hadley 1994) were of an elite group and those more recently excavated and analyzed from the surrounding compounds (Van Gerven and Sheridan 1994a) were of commoners. In summarizing biocultural stress analyses on burial groups in the commoner areas of Pueblo Grande, Van Gerven and Sheridan (1994b:127–128) state that the Classic period Pueblo Grande Hohokam were "people living on the edge of survival." Would a comparison with the platform mound inhumations indicate this was not the case for the elites? Paleopathological comparisons of such elite and commoner groups could test the hypothesis that commoners became more vulnerable to environmental fluctuations than did elites during the transition into the Classic period. If so, we would expect no differences in health between commoners and elites in the Late Formative period but differences in health between commoners and elites in the Classic Periods.

In conclusion, we agree with Waters and Ravesloot that landscape change may have been an important factor in cultural reorganization. However, we differ by emphasizing the possible political ecological factors involved in landscape change and the possibility that differential social vulnerability may explain the different impacts on the Salt and Gila River Hohokam that a purely environmental perspective cannot address. We hope that Waters and Ravesloot can test these political ecological and vulnerability hypotheses for the Hohokam in their reply. We also hope that archaeologists working in other cultural regions consider the potential in political ecology and disaster perspectives for paleohuman-environmental studies. Other related and insightful avenues for archaeologists to pursue include political-ecological vulnerability comparisons by gender, by class in state societies, by ranked groups in nonstate societies and by ethnicity (where recognizable) in multiethnic communities (Van Buren 2001:145).

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References Cited

Abbott, D. R.
2000 *Ceramics and Community Organization among the Hohokam.* University of Arizona Press, Tucson.

Ackerly, N. W.
1989 Summary and Implications of Las Acequias Findings for Hohokam Irrigation. In *Prehistoric Agricultural Activities on the Lehi-Mesa Terrace: Perspectives on Hohokam Irrigation Cycles,* edited by N. W. Ackerly and T. K. Henderson, pp. 333–347. Northland Research, Flagstaff.

Alexander, D.
1997 The Study of Natural Disasters, 1977–1997: Some Reflections on a Changing Field of Knowledge. *Disasters* 21:284–304.

Anderson, R. S., and S. J. Smith
1994 Pollen Analysis. In *The Pueblo Grande Project, Vol. 5: Environment, and Subsistence,* edited by S. Kwiatkowski, pp. 205–247. Publications in Archaeology No. 2. Soil Systems, Phoenix.

Bahre, C. J.
1991 *A Legacy of Change: Historic Human Impact on Vegetation in the Arizona Borderlands.* The University of Arizona Press, Tucson.

Barnes, M. R.
1984 Hispanic Period Archaeology in the Tucson Basin: An Overview. *Kiva* 49:213–224.

Bassett, T. J.
1988 The Political Ecology of Peasant-Herder Conflicts in the Northern Ivory Coast. *Annals of the Association of American Geographers* 78:453–472.
Bawden, G., and R. M. Reycraft (editors)
2000 *Environmental Disaster, and the Archaeology of Human Response.* Maxwell Museum of Anthropology, Anthropological Papers No. 7, Albuquerque.
Bayman, J. M.
1999 Craft Economies in the North American Southwest. *Journal of Archaeological Research* 7:249–299.
Bayman, J. M., M. R. Palacios-Fest, and L. W. Huckell
1997 Botanical Signatures of Water Storage Duration in a Hohokam Reservoir. *American Antiquity* 62:103–111.
Bayman, J. M., and M. S. Shackley
1999 Dynamics of Hohokam Obsidian Circulation in the North American Southwest. *Antiquity* 73:836–845.
Bender, B. A.
1992 Theorizing Landscapes and the Prehistoric Landscapes of Stonehenge. *Man* 27:735–755.
1993 *Landscape: Politics and Perspectives.* Berg, Oxford.
Blaikie, P., T. Cannon, I. Davis, and B. Wisner
1994 *At Risk: Natural Hazards, People's Vulnerability, and Disasters.* Routledge, London.
Bohrer, V. L.
1991 Recently Recognized Cultivated and Encouraged Plants Among the Hohokam. *Kiva* 56:227–235.
Bolin, R., and L. Stanford
1999 Constructing Vulnerability in the First World: The Northridge Earthquake in Southern California, 1994. In *The Angry Earth: Disaster in Anthropological Perspective,* edited by A. Oliver-Smith and S. M. Hoffman, pp. 89–112. Routledge, New York.
Bostwick, T. W., and C. E. Downum
1994 Site Structure and Ceremony at Pueblo Grande. In *Archaeology of the Pueblo Grande Platform Mound and Surrounding Features, Vol. 2: Features in the Central Precinct of the Pueblo Grande Community,* edited by T. W. Bostwick and C. E. Downum, pp. 297–386. Anthropological Papers No. 1. Pueblo Grande Museum, Phoenix.
Bottema, S., G. Entjes-Nieborg, and W. Van Zeist (editors)
1990 *Man's Role in the Shaping of the Eastern Mediterranean Landscape.* A. A. Balkema, Rotterdam.
Brunson-Hadley, J. L.
1994 Inhumation Burials. In *Archaeology of the Pueblo Grande Platform Mound and Surrounding Features, Vol. 2: Features in the Central Precinct of the Pueblo Grande Community,* edited by T. W. Bostwick and C. E. Downum, pp. 185–215. Anthropological Papers No. 1. Pueblo Grande Museum, Phoenix.
Bryant, R. L., and S. Bailey
1997 *Third World Political Ecology.* Routledge, London.
Cable, J. S., and D. E. Doyel
1987 Pioneer Period Village Structure and Settlement Pattern in the Phoenix Basin. In *The Hohokam Village: Site Structure and Organization,* edited by D. E. Doyel, pp. 21–70. American Association for the Advancement of Science, Glenwood Springs, Colorado.
Cambell, C. E.
1996 Forest, Field, and Factory: Changing Livelihood Strategies in Two Extractive Reserves in the Brazilian Amazon. Unpublished Ph.D. dissertation, Department of Anthropology, University of Florida, Gainesville.
Crown, P. L.
1987 Classic Period Hohokam Settlement, and Land Use in the Casa Grande Ruins Area, Arizona. *Journal of Field Archaeology* 14:147–162.
1991 The Hohokam: Current Views of Prehistory and the Regional System. In *Chaco & Hohokam: Prehistoric Regional Systems in the American Southwest,* edited by P. L. Crown and W. J. Judge, pp. 135–157. School of American Research Press, Santa Fe.
Crumley, C. L. (editor)
1994 *Historical Ecology: Cultural Knowledge and Changing Landscapes.* School of American Research Press, Santa Fe.
Dean, J. S.
1987 Thoughts on Hohokam Settlement Behavior: Comments on "The Hohokam Village." In *The Hohokam Village: Site Structure and Organization,* edited by D. E. Doyel, pp. 253–262. American Association for the Advancement of Science, Glenwood Springs, Colorado.
Dean, J. S., W. H. Doelle, and J. D. Orcutt
1994 Adaptive Stress, Environment, and Demography. In *Themes in Southwest Prehistory,* edited by G. J. Gumerman, pp. 53–86. School for American Research Press, Santa Fe.
DeVries, G. W.
2000 Post-Hurricane Reconstruction in La Moskitia, Honduras. Unpublished M. A. thesis, Department of Anthropology, University of Florida, Gainesville.
Dobyns, H. F.
1981 *From Fire to Flood: Historic Human Destruction of Sonoran Desert Riverine Oases.* Ballena Press, Socorro, New Mexico.
Doyel, D. E.
1976 Classic Period Hohokam in the Gila River Basin, Arizona. *Kiva* 42:27–38.
1980 Hohokam Social Organization, and the Sedentary to Classic Transition. In *Current Issues in Hohokam Prehistory: Proceedings of a Symposium,* edited by D. E. Doyel and F. Plog, pp. 23–40. Anthropological Research Papers No. 23. Arizona State University, Tempe.
1981 *Late Hohokam Prehistory in Southern Arizona.* Contributions to Archaeology No. 2. Gila Press, Scottsdale, Arizona.
1991a Hohokam Exchange, and Interaction. In *Chaco & Hohokam: Prehistoric Regional Systems in the American Southwest,* edited by P. L. Crown and W. J. Judge, pp. 225–252. School of American Research Press, Santa Fe.
1991b Hohokam Cultural Evolution in the Phoenix Basin. In *Exploring the Hohokam: Prehistoric Desert Peoples of the American Southwest,* edited by G. J. Gumerman, pp. 231–278. University of New Mexico Press, Albuquerque.
1998 Vacant Ceremonial Centers Revisited. *Kiva* 64:225–244.
Doyel, D. E., and B. E. Ensor
1997 Culture History of the Middle Gila. In *Archaeological Survey in Districts 6 and 7, Gila River Indian Community, Vol. 1: Research Orientation and Results,* edited by D. E. Doyel and B. E. Ensor, pp. 5–14. Report No. 98. Archaeological Consulting Services, Tempe, Arizona.
Ensor, B. E., and D. E. Doyel
1997 Trends in Subsistence, Settlement, and Land Use. In *Archaeological Survey in Districts 6 and 7, Gila River Indian Community, Vol. 1: Research Orientation and Results,* edited by D. E. Doyel and B. E. Ensor, pp. 75–104. Report No. 98. Archaeological Consulting Services, Tempe, Arizona.
1998 *Historic Pee Posh Irrigation Communities.* Paper presented at the Spring Meeting of the Arizona Archaeological Council, Phoenix. Manuscript on file at the U. S. Bureau of Reclamation, Phoenix Area Office.
Ezell, P. H.
1983 History of the Pima. In *Southwest,* edited by A. Ortiz, pp. 149–160. Handbook of North American Indians, vol. 10. W. C. Sturtevant, general editor. Smithsonian Institution

Press, Washington, D.C.
Gasser, R. E., and S. M. Kwiatkowski
1991 Regional Signatures of Hohokam Plant Use. *Kiva* 56:207–226.
Graf, W. L.
1988 *Fluvial Processes in Dryland Rivers.* Springer-Verlag, New York.
Graybill, D.
1989 The Reconstruction of Prehistoric Salt River Streamflow. In *The 1982–1984 Excavations at Las Colinas: Environment and Subsistence,* edited by D. A. Graybill, D. A. Gregory, F. L. Nials, S. K. Fish, R. E. Gasser, C. H. Miksicek, and C. R. Szuter, pp. 25–38. Arizona State Museum Archaeological Series No. 162. University of Arizona, Tucson.
Gregory, D. A.
1987 The Morphology of Platform Mounds and the Structure of Classic Period Hohokam Sites. In *The Hohokam Village: Site Structure and Organization,* edited by D. E. Doyel, pp. 183–210. American Association for the Advancement of Science, Glenwood Springs, Colorado.
1991 Form and Variation in Hohokam Settlement Patterns. In *Chaco & Hohokam: Prehistoric Regional Systems in the American Southwest,* edited by P. L. Crown, and W. J. Judge, pp. 159–193. School of American Research Press, Santa Fe.
Gregory, D. A., and G. Huckleberry
1994 *An Archaeological Survey in the Blackwater Area: The History of Human Settlement in the Blackwater Area.* Cultural Resources Report No. 86. Archaeological Consulting Services, Tempe.
Hackenberg, R. A.
1983 Pima and Papago Ecological Adaptations. In *Southwest,* edited by A. Ortiz, pp. 161–177. Handbook of North American Indians, vol. 10. W. C. Sturtevant, general editor. Smithsonian Institution Press, Washington, D.C.
Hackenberg, R. A., and B. L. Fontana
1974 *Aboriginal Land Use and Occupancy of the Pima-Maricopa Indians.* Garland, New York.
Haury, E. W.
1976 *The Hohokam: Desert Farmers & Craftsmen.* The University of Arizona Press, Tucson.
Hewitt, K. (editor)
1983 *Interpretations of Calamity from the Viewpoint of Human Ecology.* Allen & Unwin, Boston.
1997 *Regions of Risk: A Geographical Introduction to Disasters.* Longman, London.
Hirsch, E., and M. O'Hanlon (editors)
1995 *The Anthropology of Landscape: Perspectives on Place and Space.* Clarendon Press, Oxford.
Huckleberry, G.
1994 Contrasting Channel Response to Floods on the Middle Gila River, Arizona. *Geology* 22:1083–1086.
1999 Stratigraphic Identification of Destructive Floods in Relict Canals: A Case Study from the Middle Gila River, Arizona. *Kiva* 65:7–33.
Ingold, T.
1993 The Temporality of the Landscape. *World Archaeology* 25:152–174.
1995 Building, Dwelling, Living: How Animals and People Make Themselves at Home in the World. In *Shifting Contexts: Transformations in Anthropological Knowledge,* edited by M. Strathern, pp. 58–80. Routledge, New York.
Kwiatkowski, S.
1994 Prehistoric Biotic Communities, and Ecosystem Dynamics Near Pueblo Grande. In *The Pueblo Grande Project, Vol. 5: Environment and Subsistence*, edited by S. Kwiatkowski, pp. 5–34. Publications in Archaeology No. 20. Soil Systems, Phoenix.
Lees, S. H., and D. G. Bates
1990 The Ecology of Cumulative Change. In *The Ecosystem Approach in Anthropology: From Concept to Practice,* edited by E. F. Moran, pp. 247–277. University of Michigan Press, Ann Arbor.
Leighly, J.
1965 *Land and Life: A Selection from the Writings of Carl Ortwin Sauer.* University of California Press, Berkeley.
Leone, M. P.
1995 A Historical Archaeology of Capitalism. *American Anthropologist* 97:251–268.
López, M.
1999 La contribución de la Anthropología al estudio de los desastres: el caso del Huracán Mitch en Honduras y Nicaragua. *YAXKIN* 18:5–18.
Masse, W. B.
1991 The Quest for Subsistence Sufficiency and Civilization in the Sonoran Desert. In *Chaco & Hohokam: Prehistoric Regional Systems in the American Southwest,* edited by P. L. Crown and W. J. Judge, pp. 195–223. School of American Research Press, Santa Fe.
McGuire, R.
1992 *Death, Society, and Ideology in a Hohokam Community.* Westview Press, Boulder.
McGuire, R. H., and A. V. Howard
1987 The Structure and Organization of Hohokam Shell Exchange. *Kiva* 52:113–146.
Meister, C. W.
1975 Historical Demography of the Pima and Maricopa Indians of Arizona (USA), 1846–1974. Unpublished Ph.D. dissertation, University of Michigan, Ann Arbor.
Miller, J.
1994 Pueblo Grande Flotation, Macrobotanical, and Wood Charcoal Analysis. In *The Pueblo Grande Project, Vol. 5: Environment and Subsistence,* edited by S. Kwiatkowski, pp. 127–204. Publications in Archaeology No. 20. Soil Systems, Phoenix.
Moore, D. S.
1993 Contesting Terrain in Zimbabwe's Eastern Highlands: Political Ecology, Ethnography, and Peasant Resource Struggles. *Economic Geography* 69:380–401.
Moseley, M. E.
1999 Convergent Catastrophe: Past Patterns and Future Implications of Collateral Natural Disasters in the Andes. In *The Angry Earth: Disaster in Anthropological Perspective,* edited by A. Oliver-Smith and S. M. Hoffman, pp. 59–71. Routledge, New York.
Nials, F. L., D. A. Gregory, and D. A. Graybill
1989 Salt River Streamflow and Hohokam Irrigation Systems. In *The 1982–1984 Excavations at Las Colinas: Environment and Subsistence,* edited by D. A. Graybill, D. A. Gregory, F. L. Nials, S. K. Fish, R. E. Gasser, C. H. Miksicek, and C. R. Szuter, pp. 59–78. Arizona State Museum Archaeological Series No. 162. University of Arizona, Tucson.
Nicholas, L., and J. Neitzel
1984 Canal Irrigation and Sociopolitical Organization in the Lower Salt River Valley: A Diachronic Analysis. In *Prehistoric Agricultural Strategies in the Southwest,* edited by S. K. Fish and P. R. Fish, pp. 161–178. Anthropological Research Papers No. 33. Arizona State University, Tempe.
Oliver-Smith, A.
1998 Global Changes and the Definition of Disaster. In *What is a Disaster? Perspectives on the Question,* edited by E. L. Quarentelli, pp. 177–194. Routledge, London.
1999 Peru's Five Hundred Year Earthquake: Vulnerability in

Historical Context. In *The Angry Earth: Disaster in Anthropological Perspective,* edited by A. Oliver-Smith and S. M. Hoffman, pp. 75–88. Routledge, New York.

Olivo, M.
2002 Relocating Morolica: Gendered Resilience and Vulnerability in Post-Mitch Honduras. Unpublished Ph.D. dissertation, Department of Anthropology, University of Florida, Gainesville.

Patterson, W. A., and K. E. Sassaman
1988 Indian Fires in the Prehistory of New England. In *Holocene Human Ecology in Northeastern North America,* edited by G. P. Nicholas, pp. 107–135. Plenum Press, New York.

Phillips, B. G.
1997 Geomorphic Investigations. In *Archaeological Survey in Districts 6 and 7, Gila River Indian Community, Vol. 1: Research Orientation and Results,* edited by D. E. Doyel and B. E. Ensor, pp. 23–29. Report No. 98. Archaeological Consulting Services, Tempe, Arizona.

Powell, M. L.
1988 *Status and Health in Prehistory: A Case Study of the Moundville Chiefdom.* Smithsonian Institution Press, Washington, D.C.

Rea, A. M.
1997 *At the Deserts Green Edge: An Ethnobotany of the Gila River Pima.* The University of Arizona Press, Tucson.

Reycraft, R. M., and G. Bawden
2000 Introduction: Environmental Disaster and the Archaeology of Human Response. In *Environmental Disaster and the Archaeology of Human Response,* edited by G. Bawden and R. M. Reycraft, pp. 1–10. Maxwell Museum of Anthropology, Anthropological Papers No. 7, Albuquerque.

Rice, G. E.
1998 War and Water: An Ecological Perspective on Hohokam Irrigation. *Kiva* 63:263–301.
2001 Warfare and Massing in the Salt, and Gila Basins of Central Arizona. In *Deadly Landscapes: Case Studies in Prehistoric Southwestern Warfare,* edited by G. E. Rice and S. A. LeBlanc, pp. 289–329. The University of Utah Press, Salt Lake City.

Santley, R. S., S. A. Nelson, B. K. Reinhardt, C. A. Pool, and P. J. Arnold III.
2000 When Day Turned to Night: Volcanism and the Archaeological Record from the Tuxtla Mountains, Southern Veracruz, Mexico. In *Environmental Disaster and the Archaeology of Human Response,* edited by G. Bawden and R. M. Reycraft, pp. 143–162. Maxwell Museum of Anthropology, Anthropological Papers No. 7, Albuquerque.

Sauer, C. O.
1947 Early Relations of Man to Plants. *Geographical Review* 37:1–25.
1975 *Man in Nature: America Before the Days of the White Man.* Turtle Island Foundation, Berkeley.

Schmink, M., and C. Wood
1987 The "Political Ecology" of Amazonia. In *Lands at Risk in the Third World: Local-Level Perspectives,* edited by P. D. Little, M. M. Horowitz, and A. E. Nyerges, pp. 38–57. Westview Press, Boulder.

Sen, A.
1981 *Poverty, and Famines: An Essay on Entitlement, and Deprivation.* Clarendon Press, Oxford.

Sheets, P. D.
1999 The Effects of Explosive Volcanos on Ancient Egalitarian, Ranked, and Stratified Societies in Middle America. In *The Angry Earth: Disaster in Anthropological Perspective,* edited by A. Oliver-Smith and S. M. Hoffman, pp. 36–58. Routledge, New York.

Sheridan, T. E.
2001 Cows, Condos, and the Contested Commons: The Political Ecology of Ranching on the Arizona-Sonora Borderlands. *Human Organization* 60:141–152.

Shipley, G., and J. Salmon (editors)
1996 *Human Landscapes in Classical Antiquity.* Routledge, London.

Sires, E. W., Jr.
1987 Hohokam Architectural Variability and Site Structure during the Sedentary-Classic Transition. In *The Hohokam Village: Site Structure and Organization,* edited by D. E. Doyel, pp. 171–182. American Association for the Advancement of Science, Glenwood Springs, Colorado.

Smith, S. J., C. H. Miksicek, S. R. James, and J. Hutira
1995 Biological Remains. In *The Prehistoric Archaeology of Heritage Square,* edited by T. K. Henderson, pp. 151–177. Anthropological Papers No. 3. Pueblo Grande Museum, Phoenix.

Spicer, E. H.
1962 *Cycles of Conquest: The Impact of Spain, Mexico, and the United States on the Indians of the Southwest, 1533–1960.* University of Arizona Press, Tucson.

Stine, L. F., M. Zierde, L. M. Prucker, and C. Judge (editors)
1997 *Carolina's Historical Landscapes: Archaeological Perspectives.* University of Tennessee Press, Knoxville.

Stonich, S.
1993 *"I Am Destroying the Land!": The Political Ecology of Poverty and Environmental Destruction in Honduras.* Westview Press, Boulder.

Susman, P., P. O'Keefe, and B. Wisner
1983 Global Disasters: A Radical Interpretation. In *Interpretations of Calamity from the Viewpoint of Human Ecology,* edited by K. Hewitt, pp. 263–283. Allen & Unwin, London.

Szuter, C. R.
1991 Hunting by Hohokam Desert Farmers. *Kiva* 56:277–291.

Teague, L. S.
1993 Prehistory and the Traditions of the O'Odham and Hopi. *Kiva* 58:435–454.

Thomas M., and J. King
1985 Hohokam Figurine Assemblages: A Suggested Ritual Context. In *Proceedings of the 1983 Hohokam Symposium,* edited by A. E. Dittert, Jr. and D. E. Dove, pp. 687–732. Arizona Archaeological Society Occasional Paper 2. Phoenix.

Tilley, C.
1994 *A Phenomenology of Landscape.* Berg, Oxford.

Toledo, V. M.
1989 *Naturaleza, producción, cultura: ensayos de ecología política.* Universidad de Veracruz, Xalapa.

Topping, P. (editor)
1997 *Neolithic Landscapes.* Oxbow Books, Oxford.

Torry, W. I.
1986a Economic Development, Drought, and Famine: Some Limitations of Dependency Explanations. *Geojournal* 12:5–18.
1986b Morality and Harm: Hindu Peasant Adjustments to Famines. *Social Science Information* 25:125–160.

Ucko, P. J., and R. Layton (editors)
1999 *The Archaeology and Anthropology of Landscape: Shaping Your Landscape.* Routledge, London.

Van Buren, M.
2001 The Archaeology of El Niño Events and Other "Natural" Disasters. *Journal of Archaeological Method and Theory* 8:129–149.

Van Gerven, D. P., and S. G. Sheridan (editors)
1994a *The Pueblo Grande Project, Vol. 6: The Bioethnogra-*

phy of a Classic Period Hohokam Population. Soil Systems Publications in Archaeology No. 20, Phoenix.

1994b A Biocultural Reconstruction of a Classic Period Hohokam Community. In *The Pueblo Grande Project, Vol. 6: The Bioethnography of a Classic Period Hohokam Population,* edited by D. P. Van Gerven and S. G. Sheridan, pp. 123–128. Soil Systems Publications in Archaeology No. 20, Phoenix.

Van Keuren, S., S. L. Stinson, and D. R. Abbott

1997 Specialized Production of Hohokam Plain Ware Ceramics in the Lower Salt River Valley. *Kiva* 63:155–175.

Waddington, C.

1999 *A Landscape Archaeological Study of the Mesolithic-Neolithic in the Milfield Basin, Northumberland.* Archaeopress, Oxford.

Waters, M. R.

1992 *Principles of Geoarchaeology.* University of Arizona Press, Tucson.

Waters, M. R., and J. C. Ravesloot

2001 Landscape Change and the Cultural Evolution of the Hohokam Along the Middle Gila River and Other River Valleys in South-Central Arizona. *American Antiquity* 66:285–299.

Watts, M.

1983 On the Poverty of Theory: Natural Hazards Research in Context. In *Interpretations of Calamity From the Viewpoint of Human Ecology,* edited by K. Hewitt, pp. 124–148. Allen & Unwin, London.

Weber, D. J.

1982 *The Mexican Frontier, 1821–1846: The American Southwest Under Mexico.* University of New Mexico Press, Albuquerque.

Wilcox, D. R.

1979 The Hohokam Regional System. In *An Archaeological Test of Sites in the Gila Butte - Santan Region, South-Central Arizona,* by G. Rice, D. Wilcox, K. Rafferty, and J. Schoenwetter, pp. 77–116. Anthropological Research Papers No. 18. Arizona State University, Tempe.

Wilcox, D. R., and J. Haas

1994 The Scream of the Butterfly: Competition and Conflict in the Prehistoric Southwest. In *Themes in Southwest Prehistory,* edited by G. J. Gumerman, pp. 211–238. School of American Research Press, Santa Fe.

Wilcox, D. R., T. R. McGuire, and C. Sternberg

1981 *Snaketown Revisited.* Arizona State Museum Archaeological Series No. 155. University of Arizona, Tucson.

Wilcox, D. R., and C. Sternberg

1983 *Hohokam Ballcourts and Their Interpretation.* Arizona State Museum Archaeological Series No. 160. University of Arizona, Tucson.

Wisner, B.

1976 *Man-Made Famine in Eastern Kenya: The Interrelationship of Environment and Development.* Institute of Development Studies Discussion Paper 96. University of Sussex, Brighton.

1978 Does Radical Geography Lack an Approach to Environmental Relations? *Antipode* 10:84–95.

Wolf, E.

1972 Ownership and Political Ecology. *Anthropological Quarterly* 45:201–205.

Zarins, J.

2000 Environmental Disruption and Human Response: An Archaeological-Historical Example from South Arabia. In *Environmental Disaster and the Archaeology of Human Response,* edited by G. Bawden and R. M. Reycraft, pp. 35–49. Maxwell Museum of Anthropology, Anthropological Papers No. 7, Albuquerque.

Notes

1. Waters and Ravesloot explain the development of Hohokam culture as related to optimal river conditions occurring around A.D. 700–750. However, there is now increasing evidence for a gradual transition from the Late Archaic into what is traditionally defined as the Hohokam (e.g., Cable and Doyel 1987). Furthermore, many of the cultural shifts Waters and Ravesloot attribute only to the Classic period actually involved a continuation of prior social processes (e.g., Doyel 1998). First, Waters and Ravesloot (2001:291) include hierarchical irrigation communities among the resulting changes in the Classic period. However, long before the Classic period, the Hohokam along the Salt and Gila rivers already formed hierarchical and local irrigation communities (Crown 1987; Doyel 1981; Gregory 1991; Nicholas and Neitzel 1984). Second, many of the Classic period canal intake locations for major sites were not new "more stable" locations as Waters and Ravesloot (2001:292) claim, but were the same stable locations used in the previous periods. Third, although Waters and Ravesloot (2001:291) claim there was a diversification in subsistence at the beginning of the Classic period (no citations are provided for this claim), actual published research on the subject indicates the Hohokam always had a diversified subsistence base (e.g., Anderson and Smith 1994:246; Bohrer 1991; Miller 1994:202–203; Szuter 1991) with no evidence for an increase in diversification through time (Gasser and Kwiatkowski 1991:220). Fourth, Waters and Ravesloot claim that the Classic period "witnessed continued decline, and eventual collapse of the regional ballcourt system." However, ballcourts in use at the beginning of the Classic period are extremely rare indicating they were largely abandoned prior to the Classic period. Fifth, most of the Classic period platform mound sites were already the largest and most rapidly growing sites within their respective irrigation communities prior to the Classic period. Sixth, platform mounds were already being constructed prior to the Classic period, and accretionally grew in size illustrating a continual transition rather than a sudden change (Bostwick and Downum 1994:335; Doyel 1998:236; Gregory 1987:186–188; Wilcox et al. 1981:135–143). Although it is generally recognized by Hohokam archaeologists that there was consolidation of the irrigation networks during the transition into the Classic period (but not everywhere [Ensor and Doyel 1997:90; Wilcox 1979:114]), the sociopolitical organization behind those modifications were preexisting (Ensor and Doyel 1997:90; Nicholas and Neitzel 1984:175).

2. Because political-ecological vulnerability studies emphasize a human-ecological approach, the necessary operational definition of "landscape" differs from that used by Waters and Ravesloot. They define landscape in the following manner:

> The term "landscape," as used in this paper, refers to the geomorphic landscape—the platform on which all biological organisms (plants, humans, and other animals) interacted through time (Waters 1992). Physical landscapes are dynamic and constantly changing (e.g., the channel on a floodplain may downcut, widen, and later backfill), and humans are adapting to these changes [Waters and Ravesloot 2001:288].

Here, we follow the Carl Sauer's definition of landscape: "an

area made up of a distinct association of forms, both physical and cultural . . . in which the process of shaping is by no means thought of as simply physical" (Leighly 1965:321). This perspective on prehistoric human-environmental landscapes dates back at least to Sauer's work in the 1930s and 1940s (e.g., Leighly 1965:119–312; Sauer 1947, 1975). Landscape has received much attention in archaeological literature over the past decade (e.g., Bender 1992, 1993; Bottema et al. 1990; Crumley 1994; Hirsch and O'Hanlon 1995; Ingold 1993, 1995; Leone 1995:255–261; Patterson and Sassaman 1988; Shipley and Salmon 1996; Stine et al. 1997; Tilley 1994; Topping 1997; Ucko and Layton 1999; Waddington 1999). Most of these works view landscape as a result of human modification of the surrounding active environment or emphasize the ideological role of landscapes. Archaeologists investigating Hohokam landscapes (e.g., Ackerly 1989; Bohrer 1991; Kwiatkaowski 1994; Smith et al. 1995; Szuter 1991) frequently view the Hohokam as having altered, or intentionally manipulating, their surrounding physical environment. These perspectives on "landscape" are more compatible with a political ecological-perspective, which we apply to the remainder of this commentary.

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