LONG-TERM CULTURAL AND ECOLOGICAL RESPONSES TO CHANGES IN CLIMATE IN CENTRAL ARIZONA AD 900 - AD 1200

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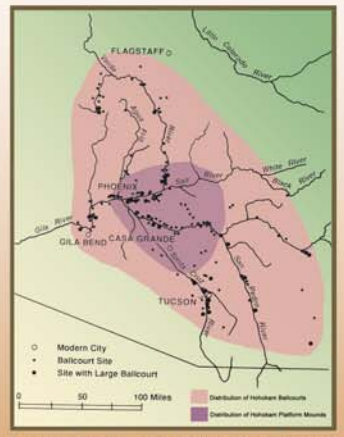
ABSTRACT

This poster reports the results of an interdisciplinary Urban Ecology IGERT workshop examining the resilience of a prehistoric Socio-Ecological System (SES) in the Phoenix Basin area. Data collected by the CES-ARI Phoenix Paleoecology Project provided information on long-term human and ecological responses to perturbations in climate at several spatial and temporal scales. Archaeologists in the Phoenix Basin area have documented significant cultural change for the prehistoric Hohokam between AD 900 and AD 1200, which marks a change from a politically more egalitarian Preclassic to a more hierarchically organized Classic Period. During the Preclassic, the Hohokam participated in a broad-scale ballcourt network, which spread from the Hohokam core area around Phoenix, to distant places across Arizona, from Tucson to Flagstaff. Archaeologists hypothesize that the ballcourt network served as an economic network redistributing spatially variable subsistence and non-subsistence resources. By the end of the Preclassic Period, ballcourts were abandoned and a new form of public architecture emerged, the platform mound. Coinciding with the collapse of the ballcourt network was a contraction of regional interaction and the primary Hohokam settlements were in the Phoenix Basin. Coincident with these regional cultural and economic transformations is a shift from spatially heterogeneous precipitation to spatially homogeneous precipitation across the Southwest US, which we document with tree ring data. We hypothesize that this large-scale climatic change is the result of shifts in Monsoonal patterns. The observed cultural changes in the core and peripheral areas appear to be predictable responses to the observed climatic and resultant ecological changes.

PANARCHY THEORY

Panarchy is a model of the changes among variables in socio-ecological systems over time. The idealized panarchy loop is illustrated in the figure above left. An adaptive cycle is plotted as changes in "Potential" (Y-axis) and "Connectedness" (X-axis). In ecological terms, these can be understood as the accumulated resources of biomass or nutrients and the degree of connectedness among controlling variables. In cultural terms, capital can be thought of as accumulated resources, facilities or knowledge, with connectedness representing the degree of interdependce among groups/institutions that control capital. Low connectedness is associated with diffuse elements at different scales loosely connected to each other, whose behavior is dominated by outward relations and affected by outside variability. High connectedness is associated with hypercoherence among elements, with an internal focus on relations that mediate external variability. The exit from the cycle indicated at the left of the figure suggests the stage where potential can leak away and where a flip is most likely into a system configured differently.

Our conception of the way this panarchy model is applied to the Hohokam Preclassic to Classic Transtion is illustrated in the figure above right. We envision the Preclassic as a time of increasingly tight coupling of the socioeconomic system to a highly variable climate, distributing resources across a large region. A subtle yet critical change in climate in the mid 1100s AD coincides with the ballcourt network falling into disuse, and a 25 year period of transition when there are no clear cultural patterns. Out of this arises a very differently configured system, one focused on maximizing access to irrigable lands in the core area, with little regional interaction.



Map shows distribution of the Ballcourt network during the Preclassic Period (in pink) and the subsequent region of platform mound construction in the core area.

CLIMATE VARIABILITY

Previous studies have not found extreme droughts or floods during the Preclassic-Classic transition. To determine whether spatial variability in precipitation might be important, tree-ring data from 3 sites along the Mogollon Rim were used to reconstruct spatial variability in precipitation from AD 960 - 1280. Data for each tree ring series were Z-score standardized and smoothed. The data were aggregated into 20-year blocks of time, and the number of years were then counted as wet (green) or dry (brown), and patchy (hatched) or homogeneous (solid). The results show significant spatial patchiness before AD 1160, and virtually none after 1160. Based on the duration of this pattern, it is likely that this shift at 1160 to relative spatial homogeneity in precipitation is the result of a large-scale climate change. Although little is known about the nature and timing of changes in the Arizona Monsoon climate phenomenon, it is possible that the shift seen in the data is related to shifts in the Monsoon. Most important for this study is the coincidence of this shift with the Preclassic-Classic transition in the late AD 1100s.

Changes in climate in 20-year intervals. Solid colors indicate spatially homogeneous years andhachure indicates pathcy years. Brown represents dry, while green represents wet conditions.

THE HOHOKAM PRECLASSIC - CLASSIC TRANSITION AD 1150 - 1200

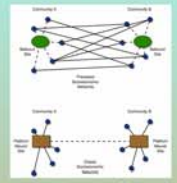
PRECLASSIC PERIOD SYSTEM

We characterize the Preclassic as having a "communal" ideology in political, economic, ritual, and social realms. The general ethos is one of open access to goods, ideas, and sharing of resources.

Political and economic. There is a dispersed placement of ballcourts across a vast region. Sites vary in the number, size, orietnation, and quality of ballcourts. Despite these differences, there is no clear center of Hohokam authority at any single settlement in the Hohokam area. In addition to this distinctive, sharedarchitectural feature is a suite of accessible Hohokam goods (e.g., Red-on-buff pottery, ritual items, stone and shell resources). The use of these items is widespread and apparently accessible to any community.

Ritual. There is seemingly open access to ritual goods (e.g., palettes, shell, censers, etc.) both spatially (across the entire region of Hohokam influence) and socially (ballcourt sites and residential sites). Ritual items emphasize themes derived from the natural world, such as herons in flight, turles, lizards, mountain goats and long horned sheep. Pottery themes depict ceremonial dancers, hunting of game, and individuals who are presumably carrying goods for trade.

Social. Preclassic residential architecture is characterized by open courtyard groups: several pithouses face towards a central courtyard creating a communal space for multiple residential units. These courtyard groups may also have an associated cemetery, indicating probable kinship affiliation. Courtyard groups and associated communities generally do not have permanent physical barriers restricting views of or access to



Hypothesized structure of Preclassic (upper) and Classic (lower) Period socioeconomic networks.

Preclassic ballcourt.

Classic Period compound.

Artist reconstruction of a Classic Period platform mound community.

CLASSIC PERIOD SYSTEM

Evidence suggests the Classic Period had a much less communal ideology in political, economic, ritual, and social realms. The general ethos is that of restricted access to and personal accumulation of space, goods, and resources.

Political and Economic. The dissolution of the ballcourt network was followed closely with the emergence of platform mound communities in the Hohokam core area of the Phoenix Basin. These appear to be strategically placed, often at the headgates and the terminii of major canals. This spatial arrangement suggests increasing control and oversight of agrarian and other economic activities for each canal system by an emerging leadership able to harness labor for constructing large ritual-administrative-residential mounds. Long distance trade networks of the Preclassic were altered during the Classic period. Exchange non-ritual goods is between specific canal systems rather than widely distributed .

Ritual. Many of the ritual items popular in the Preclassic period (eg. palettes, censers, and red-on-buff pottery) are no longer valued in the Classic Period. Control of new ritual items (shell trumpets, shell tinkler garments) shifts to the Platform Mounds Pottery motifs change from naturalistic to geometric or woven patterns, implying a shift in the methods and practices of belief into other material realms.

Social. The residential architecture of the Classic is characterized by walled compounds. Although the communal nature of space is still evident within the compound, walls restrict views of and access to living spaces. This might reflect a desire to hide personal accumulations of wealth or other resources.

DISCUSSION

The model of resource exchange and sharing during the Preclassic is manifest in residential architecture, access to ritual and exotic items, and the disbursement of public architecture across a vast region. We believe that the emergence and maintanence of this ideology was beneficial to individuals and communities during times of heterogeneous patterns of precipitation across the American Southwest. The patchy landscape of high and low precipitation was continually shifting from location to location. A broad network of resource exchange and interaction assured the distribution of resources to areas experiencing shortfalls. This strategy buffers against risk across space.

We hypothsize that the observed changes in the spatial distribution in precipitation were a result of a monsoon pattern shift in the AD 1150s. Although we do not evaluate that hypothesis here, future analysis may focus on the testing of that hypothesis through examination of vegetation community composition which should be likely in the case of an long-term climatic shift. Whatever the cause, the change in the spatial distribution of precipitation across the Hohokam region changed the underlying uncertainty to which the ballcourt network appears to have been an adaption.

The cultural transformations at this time are indicative of these large climatic patterns. An ideology of accumulation and privacy emerges. Under the new climate regime, shortfalls and surpluses would coincide across the region instead of being variable. When times are bad in one area, they are generally bad across the entire region. An argument can be made that the accumulation or hoarding of surplus would be an important new strategy for buffering against risk across time, instead of space. Interestingly, ritual and political control are relinquished to an emerging elite who provide infrastructure for defense and public works, and perhaps an ideology that promotes much more restricted sharing.

CONCLUDING THOUGHTS

The Panarchy model provided a useful heuristic for thinking about social and environmental dyanmcs. The "connectedness" variable, in particular, helped us to think about the ballcourt network in a new way, and enriched our study. A full elaboration of the Panarchy model in this case would require a consideration of smaller scale dynamics within Hohokam sub-regions. The interaction of these smaller scale elements with the larger scale model elaborated here might provide a critical linkage between the proposed climate change and the apparent cultural changes that occur during the Preclassic-Classic transition. It can also provide a means for exploring why social systems experience transformation as a result of external perturbations in some instances but not in others.