ENVIRONMENTAL DETERMINANTS OF SITE FORMATION: A COMPARISON OF ETHNOARCHAEOLOGICAL WORK IN THE KALAHARI DESERT AND ITURI FOREST WITH IMPLICATIONS FOR THE "EMERGENCE" OF HUMAN CULTURE

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Environmental determinants of site visibility: Comparative ethnoarchaeology in the Kalahari Desert and Ituri Forest with Implications for the "Emergence" of Human Culture

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Abstract. Ethnoarchaeological work in two regions of Africa suggests that hunter-gatherer archaeological sites are most likely to form when landscape points are used repeatedly, even if only very briefly, over a long period. Long-term repeated use of a landscape point is most likely for campsites in the Ituri, since forest clearing for new campsites is difficult. In the Kalahari, on the other hand, long-term landscape use is most intense at water-points used for ambush hunting during seasonally restricted periods. Since the location of forest clearings is likely to change over a period of centuries, while the location of water points is likely to remain constant, archaeological sites accumulate in the Kalahari and the Ituri at different rates. This ethnoarchaeological prediction is confirmed by archaeological survey in the two regions. In addition, computer simulation comparing forested environments with more open and semiarid ones suggests that climatic change alone could account for the "emergence" of archaeological sites representing a population of early hominids that already used tools but did not concentrate their behaviors spatially over long time periods.

We propose to define the term "**first-order** ethnoarchaeology" as the collection of primary data about the patterning and determinants of activities in the ethnographic present, with particular reference to the generation of material remains. **Second-order** ethnoarchaeology, then, is the translation of the ethnographically-observed pattern into a predicted archaeological one by factoring in what is known about variation in these activities over significant periods of time. Second-order predictions from ethnoarchaeology can be tested directly by reference to the archaeological record, preferably while holding history, culture and landscape as constant as possible. In **third-order** ethnoarchaeology, comparisons of different landscapes and use-patterning over archaeological time lead to predictions about the causes of observed similarities and differences in **both** the ethnographic and the archaeological records. In this paper, we follow this scheme in using two long-term ethnoarchaeological studies of hunter-gatherers in very different African landscapes -- the northwest Kalahari desert of Botswana and the Ituri Forest of Zaire -- to offer alternative explanations for the apparent concentration of Pleistocene archaeological sites in savanna and semi-arid zones in Africa, as well as for the initial appearance of tools at ca. 2.6 mya.

Focus and Stability in Ethnoarchaeological landscapes

We suggest that three **separate** factors ultimately shape the pattern of time-averaged archaeologically-visible signatures on the landscape:

1. *Redundancy*: an artifact or residue producing activity is repeatedly carried out by hominids possessing a material culture.
2. *Focus*: the activity is likely to be carried out on the same location on the landscape in ethnographic timescales (i.e., there is a geographical "focal point" for the activity), and
3. *Lifespan* of focal points: the landscape location (focal point) is likely to remain stable over archaeological timescales.

Redundant activities are essential in the formation and interpretation of archaeological patterns. First order ethnoarchaeology tends to identify the most redundant activities (relative to other activities) as most likely to contribute to material signatures, depending on the degree of preservation of material outputs of such activities.

The importance of **focus** is illustrated by a hypothetical comparison of a woodland and a grassland, with many and few shade trees, respectively. A behavior that is likely to be done in the shade, and that produces preservable residue, is likely to produce distinctly different archaeological patterns in these two habitats, all else being equal. In the woodland, with many shade trees to choose from, artifacts may end up distributed thinly across the landscape, while in the grassland (with a small number of trees) the same behavior, representing the same proportion of activities, may result in fewer, but very dense concentrations of debris. The former may be archaeologically invisible (or at least, may seem archaeologically unimportant), while the latter may constitute a major part of the archaeological record (and thus seem very important to investigating archaeologists, regardless of its importance in a living system).

Over the short term, activities of similar redundancy may result in different archaeological patterns because of differences in focus. But in the long term, the lifespan of focal points (factor 3) may be more important in shaping an archaeological record. This can be illustrated by a hypothetical comparison between a landscape with a limited number of shade trees and a landscape with the same number of stone outcrops, both providing focal points for an activity. We may presume that trees have a lifespan of about a century, and stone outcrops have a lifespan of several thousand years. New trees crop up as old ones fall, while the stone outcrops remain in the same position for a long period of time. Over several centuries, the accumulation associated with the trees would form numerous small scatters, while the accumulation associated with the stone outcrops would be highly concentrated in a smaller number of localities. One system of behavior on two different landscapes would appear similar over short, ethnographic time periods, but would be very different over archaeological time.

It is likely that the effects of focus and lifespan are similar across a wide range of behavioral systems with respect to a single class of activity. For example, quarry sites should almost always be associated with rare, long-lived geological features, and thus should often be

highly visible, while nut-cracking with stone tools should almost always result in a dispersed component of the archaeological record. The most interesting effects of focus and lifespan, however, may be when the archaeological record of similar activities are shaped very differently in different contexts. For examples of this we turn to the ethnographic record of Ju and the Efe camps and ambush hunting sites.

The northwest Kalahari vs. the Ituri

Most of the artifact producing activities of the Zu[1] of the northwest Kalahari (see Brooks and Yellen 1987; 1992) occur in residential camps. Camps, in turn, can be divided into two types: long-duration dry season camps within a 4-9 km^2 area surrounding permanent water sources but not within 0.5 km. of these sources. Rainy season camps, in contrast, are both short-duration and relatively unfocussed in space, occurring throughout much of the ca. 1000 km^2 of a group's total range. (Yellen, 1977, Brooks and Yellen 1987).

One spatially-focused activity occurs outside residential camps, but so rarely that it took us years to see its importance. (Brooks, Crowell and Yellen, 198**?**). Zu ambush hunting and subsequent butchery occurs on the margins of the deepest water sources after shallower sources have dried up following the rains (April to early June). These water sources are extremely stable features on the landscape. As a full m oon is required for this all-night activity, ambush-hunting is limited to a few days per year at most. One or two men arrive in the afternoon and rebuild the appropriate pre-existing blind, depending on wind direction. A fire may be built against the night chill typical of this season. Men may snack or repair weapons while waiting. This type of hunting, although rare in ethnographic time, is up to 5-15 times more successful than stalking, in terms of meat gained per hour, and often results in primary butchery at the site. Successive reuse of an ambush site overlap almost completely, and few good sites are available at any one time.

In the Ituri Forest, Efe hunter-gatherers focus their activities in ethnographic time in camps, and along trails, and make use of ambush sites (Laden, 1990, 1992). Efe relocate their

[1] As used here, the term Zu refers to the "ethnographically present" bushmen people of a particular part of the Kalahari, while the term "San" generally refers to the more wide spread ethnographically *and* archaeologically documented bushmen. Throughout this discussion, we speak in terms of the ethnographic present.

camps on almost exactly the same spot numerous times, and a particular forest camp will almost always be re-occupied within a year or two of the last occupation.

Efe ambush-hunting is much more frequent than Zu ambush hunting, accounting for a large portion of their meat. Efe use simple scaffolds built in trees overlooking fruit falls that attract small forest animals. Hunters spend an hour or so in the morning or early evening in these blinds, and conduct no activities there, other than waiting and observing. If the hunt is successful, the small forest animal prey are carried whole to camp for butchery. Perhaps dozens of good ambush sites exist near each camp. The combination of fruit fall and good ambush tree may have a combined lifespan measured in decades, at most.

For both Zu and Efe, there is a considerable degree of behavioral redundancy with respect to camp use. However, Zu camps are only moderately focused in space while Efe camps are highly focused in space. It is likely that Zu camps "outlive" Efe camps by a significant margin. In contrast, Zu ambush sites are highly focused in space while Efe ambush activities are less focused in space. The landscape features constraining Zu ambush hunting, however, are of extremely long lifespan, while those constraining Efe ambush hunting use are fare less than a human lifetime.

Ethnoarchaeology can be used to make a series of predictions depending on which "order" of ethnoarchaeological analysis is carried out, which is partly related to the time frame being considered. First order analysis would determine that ambush hunting is more likely to be archaeologically visible for the Efe than for the Ju, even though few preservable objects would be left per Efe ambush hunt. Ju ambush hunting is so rare that it may even be overlooked by ethnoarchaeologists spending a mere few years in the field. At the same level of analysis, both groups have roughly similar distributions of activities with respect to camps (but see Laden 1992 for the role of trails in this regard). This pattern of predictions results from the fact that the first order ethnoarchaeology primarily addresses patterns of redundancy in the living system.

Second-order ethnoarchaeology would predict that over thousands of years, the pan margin ambush sites of the Zu, even though occupied only about 2 nights per year, would be highly visible archaeologically, while dry season camps, less focused in space, would be somewhat less visible archaeologically. Rainy season camps, and other highly dispersed

activities such as gathering would be nearly invisible. In the Ituri, one would expect to find camps to be more visible than ambush hunting sites, but neither represented as a highly visible concentration. (An important exception to this is rock shelters, to be treated in a different paper.)

Second-order predictions and the archaeological record

If we turn to the actual archaeological records of the two areas, we note that in the northwest Kalahari (Brooks, 1978, 1984; Yellen and Brooks, 1988), easily visible primary context stone-age sites exist and are concentrated within 2 km. of permanent water sources. The densest and most visible sites are immediately adjacent to pans in areas used ethnographically almost exclusively for ambush hunting. These densest sites also contain a predominance of weapons and **ad-hoc** tools, and a paucity of carefully-made scrapers. Some rockshelters also appear to have been activity foci (Yellen and Brooks 1987). Less dense and more dispersed concentrations of artifacts and fauna occur at distances of 0.5 to 2 km from water sources, and are characterized by a wide range of tools including scrapers of various types. This conforms to the predicted pattern.

In the Ituri Forest, there are few primary context sites outside of rock shelters. Surveys by Laden (as well as Desmond Clark, Glynn Isaac, and Jack Fisher; see Laden 1992 for a summary) in the Ituri found numerous Later Stone Age sites, but outside of rockshelters, these sites are rare and of extremely low density. LSA artifacts are typically found in very low density in existing Efe camps (three or four lithic pieces per square meter). Again, this conforms to the predicted pattern.

Modeling the Ituri and Kalahari

Since most of Africa is neither the Kalahari nor the Ituri, Computer simulation and mathematical modeling based on these two extremes may allow the analysis of artifact accumulating systems in intermediate settings. Also, by modeling the processes observed in these two places, we can vary crucial parameters to determine the sensitivity of the outcome to each relevant factor, and observe changes in the roles of each factor over different time scales. We have applied a number of different modeling techniques to Ju and the Efe camp and ambush

hunting activities, and to other activity classes (Laden, 1993; Laden and Brooks, 1994). Here, we present only the results of a single stochastic simulation. This simulation takes account of the relative importance of ambush hunting, activities in camps, high-density plant-food gathering, and randomly located foraging activities, based on first-order ethnographic study of the Efe and the Ju.

The layout of the landscape for both the Zu and Efe for use in the simulation is shown in Figure 1. The simulated Zu landscape includes two potential camp areas, two groves were important plants are concentrated, and two pans with several ambush sites. In addition, plant and animal foods can be obtained randomly throughout this made-up landscape. The simulated Efe landscape has two camps connected by a trail, along which are groves of useful plants, honey-bearing trees, and a few "megatrees" (long-lived tress that produce tremendous amounts of fruit or nuts seasonally), and a number of possible ambush sites.

Figure 1 also presents a typical result of a stochastic simulation of hypothetical Zu and Efe landscapes, using parameters derived from first-order ethnographic analysis. The vertical axis represents the density of theoretical artifacts produced by running this simulation for 1,000 years, holding the artifact production per activity constant, and estimating the relative intensity of activities from first-order ethnographic data. Focus and lifespan for each set of landscape features are estimated to resemble the Ju and Efe landscapes, although estimates in both cases are conservative, making the two landscapes more similar to each other in this simulation than they probably are in reality.

Artifact density indicated on these plots can be considered as a rough estimator of archaeological visibility of each type of activity. Each simulated landscape possesses a small number of "spikes" and a background scatter of individual artifacts or small patches. Note that the scale of the vertical axis in each graph is different, so that the largest spikes for the Ju plot are higher than those for the Efe by an order of magnitude.

The tallest spikes on the Ju plot are all in ambush hunting sites, while the spikes on the Efe plot mainly represent camps, with the ambush sites blending into the background scatter. In both cases, only one class of activity area use is well represented. More importantly, Ju ambush hunting would appear to be the most important activity (archaeologically) on that

landscape, in stark contrast to the ethnographic reality. Efe ambush hunting would likely not be noticed at all in the archaeological record, despite it's importance in the Efe's subsistence economy.

Figure 2 shows the mean frequency of reuse per ambush site from the beginning of the simulation through 1000 years. While the behavioral differences between the two modeled groups does not change over time, the longer the two systems exist and more different they appear, with respect to site density. In comparing the two landscapes for the first several years of the simulation, Efe ambush hunting appears to be more important than Ju ambush hunting, which reflects the observations of first-order ethnoarchaeology. However, sometime after the average lifespan of the Efe ambush sites is attained, Efe ambush site density begins to flatten out, while the Ju sites continue to grow in density. Thus we see that the temporal landscape effects we outline in this paper are initially irrelevant, so that a young archaeological record may closely resemble that observed in first-order ethnoarchaeological study. But over time, these effects become more important than the living system itself, to a degree proportional to the age of the system on a particular landscape.

Implications for the Early Stone Age of Africa

What does all this have to do with the Early Stone Age Theme at the Pan African Congress of Prehistory and Related Studies? We suggest that the difference between two regions in the relative importance of long-lived and highly-focused landscape features can make the difference between artifact-producing behaviors being visible and invisible. Climate change within a region can also lead to a change from visibility to invisibility or back. Were we to superimpose the distribution of sites in Africa on a map averaging climate over the last million years or so, we might see that topographically-mediated drainage points, serving as long-term foci of hominid activities, should have the oldest and richest archaeological record. This may be why we have so few early sites in the western rift and Central African Forest.

We would also like to introduce the possibility that the first appearance of stone tools in eastern and southern Africa between 2.5 and 1.8 mya is not an innovation in behavior or the arrival of a new, tool-using species. Suppose that australopithecine tool-making and using

behavior was similar to that of chimpanzees, but involved flaked stone. In the forest or woodland, these activities did not produce concentrations of debris. But, as the climate rapidly became drier around 2.5 mya, water sources and some plant food sources would have become more concentrated in space. Relatively long lived geological features, such as stream channels, pans, and lake shores would have greater control over the positioning of both water sources and hydraulic and soil conditions ideal for plants likely to be included in an ape diet. These effects could result in increased *focus* of some (or many?) artifact-producing activities, and at the same time, an increase in the *lifespan* of these focused patches. Together, increased focus and lifespan of economically important patches could result in a focusing of the traces of a previously existing behavior into archaeological visibility as a result of a climatic change, with little or no behavioral change being directly responsible for this important and dramatic shift in the character of the archaeological record.

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Figure 1. Stochastic simulation landscapes and results for Ju and Efe models.

Figure 2. Average site density through time for Ju and Efe models.

Figure 1.

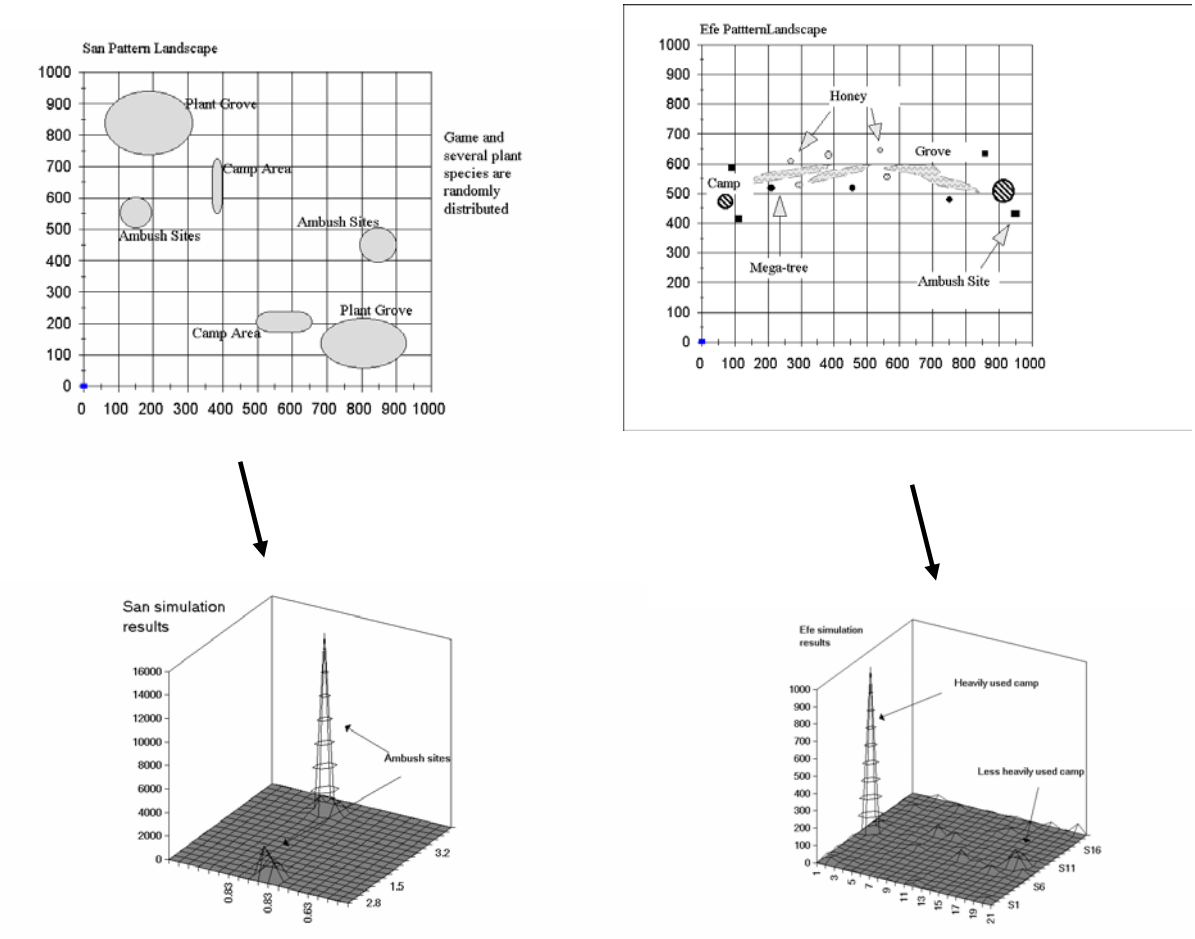

Figure 2.