Non-Boserupian Ecology and Agricultural Risk: Ethnic Politics and Land Control in the Arid Southwest

Numerous cases of increasing population without fallow shortening or intensification without population pressure have been cited as disproof of the Boserup model of agricultural change. In this paper we argue that the model is an efficient explanation for agricultural change but only when certain agroecological conditions are met: higher marginal input costs must be both necessary and sufficient to raise production. Elsewhere, conditions are non-Boserupian, and other kinds of responses should be expected. Wupatki, a prehistoric agricultural frontier, is a case in point. Boserupian intensification was mostly impossible here, and with population influx, farmers turned instead to sociopolitical means of protecting the land base for extensive agriculture. A contemporary example from Nigeria illustrates territorial control by groups consolidated along ethnic lines. The strategy of relying on increasing numbers and monumental construction to back up territorial claims had unintended long-term consequences that led to abandonment of Wupatki. [agricultural change, political ecology, settlement patterns, prehistoric Southwest, West Africa]

Population, Agriculture, and Pueblos

The ashfall left by the eruption of Sunset Crater Volcano in A.D. 1064 created a bonanza for the prehistoric inhabitants of the area around Wupatki National Monument in northern Arizona (Figure 1). This natural mulch apparently improved soil conditions enough to attract more than 2,000 immigrants during the following century (Downum and Sullivan 1990:72). A recent survey recorded more than 2,000 small sites on the 55 km² monument, but the most striking features of the cultural landscape are the numerous large pueblos that arose in the twelfth century. These include 10 pueblos of more than 20 rooms each, apparently organized into settlement districts or clusters centered on Wupatki Pueblo (150+ rooms) and Citadel (50+ rooms).

The responses to this population influx pose a challenge to general theories of population and agricultural change. There is, of course, a major body of literature on the relationship between population growth and agricultural change, much of which has been shaped by the work of (and reactions to the work of) Ester Boserup. Her model (Boserup 1965, 1981) holds that with population pressure, agriculture is "intensified," which is generally taken to mean that greater amounts of labor are put into smaller per capita amounts of land. Wupatki has been widely cited as an example of this Boserupian process (Plog 1989:281; Sullivan 1984:100; Sullivan and Downum 1991; Travis 1990:53). Although there is no consensus on what Wupatki's large pueblos had to do with intensification, many Southwesternists have attributed similar examples of prehistoric population aggregation to the labor demands of intensive agriculture. For example, Cordell and Plog (1979: 417) point to the organization of labor as a factor in the formation of large villages, and Vivian (1989:109) stresses how the need for a large, coordinated workforce for intensification promoted nucleation in Chaco Canyon (also Cordell et al. 1994; Leonard 1989).

In this paper we re-examine interactions among agriculture, population, and aggregation at Wupatki, but our larger goals are to (1) delineate the boundaries of Boserupian
intensification and (2) demonstrate a political response to population pressure under non-Boserupian conditions. We argue that the central fact of Wupatki agrarian ecology was not that farmers practiced intensification, but rather that they could not do so, because intensification would have increased risk in an environment where risk minimization was the paramount concern. Aggregation at Wupatki was indeed linked to social aspects of agricultural change, but through a causality other than agricultural labor demands. Rather than intensifying, Wupatkians took steps to protect the land base needed for extensive farming, with opposing groups apparently consolidating along ethnic lines.

Political responses to population pressure are favored in non-Boserupian contexts, but they may occur elsewhere as well; indeed, we use a contemporary example from an intensification-friendly area in Africa to illustrate ethnic-political strategies of land control. We use the Wupatki area not as an exhibit in a case against the Boserup model but rather as a stimulus for delineating the conditions under which the model does and does not apply, and for considering nonagricultural responses under non-Boserupian conditions.

Boserup and Agrarian Ecology

As first presented in 1965 and later elaborated (1981), the Boserup model offers a generalized "framework for a dynamic analysis embracing all types of primitive agricul-

ture" (1965:13). Boserup holds that extensive cultivation is normally practiced when rural population density is low enough to allow it. Extensive cultivation tends to be satisfactory in terms of output when measured per unit area; it also tends to be favorable in total labor costs and labor efficiency (output:input). Ecologically, extensive cultivation tends to capitalize on the benefits of fallowing, which eases the work of field preparation, weeding, and fertilizing. In arid environments, extensive cultivation has the benefit of diversifying the portfolio of microenvironments that respond differentially to inter-annual variation in precipitation.

When rising population density forces farmers to shorten fallow cycles, agricultural output per unit of area and time—production concentration for short—must rise. An area that had yielded \( x \) per hectare for 5 years out of 20 may now have to yield \( x \) per hectare for 5 years out of 10. As the benefits of fallowing are sacrificed, total labor costs tend to rise while efficiency drops. Achieving higher production concentration at the cost of more work at lower efficiency is what Boserup describes as agricultural intensification. The key to the model is that the labor costs of intensification are both necessary and sufficient to raise production concentration. They are necessary in that higher production requires proportionately more work, and sufficient in that the proportionate increase in work succeeds in raising output. Boserup is clear in describing a pattern of increased
workload and increased productivity as occurring when and only when it is necessitated by rising population. She argues that this general relationship crossescutts agricultural environments, even though the specific tasks of intensive farmwork obviously vary.

As generalizations go, these have turned out to be good ones: farmers with abundant land do tend to rely heavily on methods that are land-expensive and labor-cheap; farmers under more crowded conditions do tend to adopt labor-expensive (or capital-expensive) methods; and the decline in marginal utility on inputs does offer a causal mechanism for the change. The model has an impressive record of empirical support from both cross-cultural and longitudinal studies, and it has been indispensable in explaining cross-cultural agricultural variability (Netting 1993; Turner et al. 1993; Turner et al. 1977; Wiggins 1995).

It has also been a perennial target of critics. One set of criticisms faults the model for being overly evolutionary (e.g., Morrison 1996; Richards 1985:50–55). Yet the model’s real influence has been to peg land use and land tenure to local demographic and ecological factors as opposed to “grand, inclusive schema like those of cultural evolution” (Netting 1993:261). Examples of research building on Boserup’s model of population and agriculture with little reference to cultural evolution include the work of Turner et al. (1977), Turner and Doolittle (1978), Pingley et al. (1987), Netting (1990, 1993), Tiffen et al. (1994), and Stone (1996). When Boserup’s work has appeared in recent evolutionary theory, it has been as a model of recurrent involutionary cycles that form nodes in larger developmental trajectories (Lee 1986; Robinson and Schutjer 1984; Wood 1998; cf. Brookfield 1984:18), which is quite different from serving as an evolutionary stage-scheme in its own right (as Morrison [1996] envisions).

Another set of criticisms concerns the nonagricultural factors Boserup holds constant. For instance, land shortage is not the only stimulus for intensification; others include market incentives (Boserup 1990; Netting et al. 1989), “social production” (Brookfield 1972), risk reduction (Sanders and Webster 1978; Wilk 1997:95–107), and social institutions (Stone 1996:193). Likewise, intensification is not the only response to land shortage. Others include migration (Padoch 1982; Stone 1996:164–174), conflict (Stone 1997), trade (Price 1977; Smith 1975), and nonagricultural enterprises (Drennan 1988; Feinman et al. 1984). Because general models sacrifice complexity for salience, such simplifications are necessary, but Boserup may have hurt her own case by not making explicit that she was holding such factors constant. For comparison, consider von Thünen’s ([1826]1966) renowned model of the spatial organization of land use. In that work, the simplifying assumptions were not only explicit but were featured in the book’s title, The Isolated State, and his explicit use of assumptions was later seen as his master stroke (Morgan 1973:301). It is Boserup’s reticence about her assumptions that has attracted many of the critiques, which generally include an expose of one or more of these implicit assumptions coupled with an example of increasing population without fallow shortening, or intensification without population pressure. Examples include raised fields in the Bolivian Andes (Erickson 1993), paddy rice in Indonesia and the Philippines (Conelly 1992; Padoch 1985), grain farming in Kenya and southern India (Conelly 1994; Morrison 1996), and maize cultivation in the Sonoran desert of Arizona (McGuire 1984).

We believe the Wupatki case also fails to conform to Boserup’s model, but rather than counting coup on Boserup, we are interested in a more general issue: defining the agroecological conditions under which the model does and does not fit. We take issue not with her tacit assumptions, but rather with her explicit position that different fallow systems cannot “be seen as adaptations to particular types of soil or climate” (Boserup 1965:20). Our intent is not to impeach the model but to identify its ecological boundaries in order to provide a broader theoretical context for cases of non-Boserupian response.

Identifying the ecological boundaries of Boserup’s model requires recognizing that efficiency (output:input) and production concentration (farm output per unit of area and time) do not maintain a constant relationship; they can vary widely at different levels of production (Turner and Doolittle 1978) and in different local environments. There is no reason to expect the Boserup model to fit outside of the conditions that it assumes. Yet at some levels of production in some agroecological contexts, production concentration can be raised without lowering efficiency: lower efficiency is not necessary. On the other hand, at some levels of production in some agroecological contexts, production per time and area cannot be reliably raised even with harder work and lower marginal returns: lower efficiency is not sufficient.

For each level of production concentration, we can imagine a most efficient method of production; a line drawn through these optima is the theoretical “intensification slope.” Intensification slopes may be modeled at various scales. Figure 2 depicts the global slope Boserup described, the pattern emerging from the countless cases where production concentration can be raised, but at the expense of lowered efficiency. This is the broad pattern confirmed by the empirical studies cited earlier; the trend is real, and Boserup’s explanation is convincing. The large slope depicts Boserupian intensification, defined as the process of raising production concentration by accepting higher labor demands and lower efficiency.

But local conditions of agrarian ecology and technological possibility may produce very different patterns. Where lowered efficiency is not necessary for higher production concentration, the slope would be flatter, as indicated by trajectory A. For instance, raised-field agriculture as practiced in parts of prehistoric Latin America may have raised
production concentration without lowering efficiency at all. Indeed, Erickson (1993) argues that raised fields in highland Bolivia probably offered higher efficiency and higher production than extensive farming. This is apparently true of most wet-rice farming in Asia as well. Paddies tend to gain rather than lose fertility through time (Bray 1986:28), so while labor demands in wet-rice farming are high, the labor tends to be more efficient than in dry-rice cultivation (see also Padoch 1985).

The other non-Boserupian pattern occurs where production concentration cannot be raised, or where the cost of raising it is intolerable: trajectory B. This trajectory promotes nonagricultural responses as noted above. An example are the Kofyar farmers whose immigration into areas of sandy or clayey soils in the Benue Valley of Nigeria is described by Stone (1996). Unlike settlers on the sands, who adopted the intensive tactics of weeding and fertilizing, most settlers on clay eventually abandoned their farms, claiming that added work would be a waste of time. The clay soil developed drainage problems for which the Kofyar had no efficient solution. Other B situations include irrigated systems prone to salinization (e.g., Ackerly 1988), and many arid areas such as the Wupatki case described below.

This recognition of non-Boserupian conditions delineates the applicability of the model, but it by no means impeaches it. Where more work and lower efficiency are necessary and sufficient to raise production concentration, the model is highly successful in predicting and explaining agricultural variability. This directs us to seek patterning in responses to rising population under non-Boserupian conditions, and Wupatki provides an excellent case study in nonagricultural response.

**Intensification at Wupatki?**

Although direct measures of the production concentration and efficiency of prehistoric farming are impossible, there is ample reason to believe that the majority of the Wupatki-area landscape would have fit the non-Boserupian trajectory B, with the intensification slope dropping off too steeply to reward increased work on decreased land per capita. The area surrounding Wupatki is a high-elevation desert where agricultural production was severely limited by moisture deficits. Although Travis (1990:33) writes that the Wupatki uplands "receive fairly consistent moisture, to the prehistoric farmer the variability would have been alarming. Annual precipitation today averages only 210 to 280 mm across the monument, a level barely sufficient to sustain dry farming. Worse, these low average figures are accompanied by extreme monthly, yearly, and decadal fluctuations. In modern times, the average annual precipitation
of 210 mm at Wupatki Pueblo has had a standard deviation of 58 mm, and one year in five has precipitation more than one standard deviation below the mean.

Precipitation also varies across space, with much of the summer rain coming in the form of convectional storms less than 5 km in diameter, offering limited and unpredictable coverage. Moisture from low-intensity showers is quickly absorbed by an overlying mantle of volcanic tephra, so farmers were dependent on a few well-timed, heavy rainfall events. In many years, however, such rains do not occur in the needed frequency at particular field locations, so crop failure due to moisture deficit must have been frequent.

Because there is no reason to believe that there has been dramatic regional climate change since Wupatki was last occupied (Rose et al. 1981), weather data collected during the past 45 years at Wupatki provide an idea of the risks confronted by prehistoric dry farmers. Assuming conservatively that maize at Wupatki required a growing season of not less than 90 days, that it required at least 50 mm of precipitation during the first 60 days of the summer growing season, and that it could not have survived a streak of 21 rainless days during the first 60 days of summer, then it can be estimated that a dry-farmed crop of maize would have failed in 14 of the past 45 years at Wupatki. These failures would have included two cases in which crops failed in two consecutive years, and one period of five consecutive crop failures.

The Wupatki landscape offered almost no opportunities for irrigation. Arroyos could have been farmed with channel-bottom weirs or ak chin plots (e.g., Doolittle 1984, 1988:48–50; Gasser 1990), but such situations were few indeed (Figure 3). Flood recession agriculture would have been possible only in the alluvial deposits along the Little Colorado River, the only reliable stream in the area (see Figure 5). However, less than 1% of all land within 10 km of Wupatki’s main settlement districts allowed either ak chin or flood recession farming.

Under these conditions, minimizing the risk of food shortfalls would have been the top priority in agricultural decision making. Although in some settings risk minimization can be an even greater stimulus for intensification than land shortage (Nichols 1987; Sanders and Webster 1978; Wilk 1997:95–107), here it would have militated against
intensification. Given the variable rainfall and the impossi-

bility of irrigation, concentrating increased amounts of la-

bor into plots at risk of failing from lack of water would

increase risk. Those who lacked access to the few well-

watered locations at Wupatki would have had to maintain

extensive fields in diverse locations: a “balanced portfolio”
to mitigate risk (Bentley 1987; Dean 1988:35; Maxwell

and Anschuetz 1992). Wupatki seems to be a classic case

of trajectory B non-Boserupian conditions. This warrants a

reassessment of the evidence for intensification there.

The most frequently cited evidence of agricultural inten-
sification at Wupatki is the small ridges reported in Berlin

et al.’s (1977) analysis of aerial thermograms. They pro-

posed (1977:599) that as soil fertility from the ashfall was

depleted in the early 1100s, Wupatki-area farmers had to

attempt farming in more marginal localities. Resorting to

ridge construction probably was an example of Boserupian

intensification. These features were exceedingly rare, how-

ever. Berlin et al. identified only 3 small modified areas,

covering a total of around 4 hectares, and no ridged fields

were reported in a recent survey of Wupatki (although a

single example of a “cinder berm field” was recorded

[Travis 1990:12]).

Claims for intensification are also based on rock fea-
tures associated with agricultural field locations (Brown

1996). Although these features number in the thousands,

most are fairly insubstantial piles or alignments that would

have required little effort to build or maintain. Travis

(1990:13) defines seven categories of agricultural field

systems at Wupatki, based on the elaboration of rock fea-
tures. They range from fields with simple rock piles or

alignments to “terraced gardens” and “terraced fields.”

These field types probably reflect actual Boserupian inten-
sification only in the highly limited contexts where added

work on agricultural plots could have reliably raised out-

put. All “terraced gardens” are closely associated with

pueblos, where they apparently served as household gar-
dens (Travis 1990:25) and may have been hand-watered.

Terraced fields (or contour terraces) occur only on rela-
tively steep (15–30%) slopes, where they provided level

planting areas and allowed the hillside to act as a water har-
vesting system. Travis argues that his category of “bor-
dered gardens” reflects intensive cultivation, including soil

and water conservation and addition of household trash.

These features, too, are highly infrequent and usually close
to major habitations. We agree with Travis’s assessment:

While a substantial effort must have gone into the selection,
original construction, and continued maintenance of these
fields, anticipating sustained yields year after year, their very
infrequency suggests that they contributed minimally to over-
all agricultural subsistence: and were used instead for specific
types of cultigens requiring continuous care. [1990:23]
The most common agricultural features are classified as “simple fields,” which typically “appear as a limited number of alignments with few if any outlying field facilities” (Travis 1990:18–19). These alignments (Figure 4-A) are often interpreted as anchors for brush fences, as Hack (1942) described in his study of 1930s Hopi farming. This is plausible but does not mean Wupatki fields were used as intensively as twentieth-century Hopi dune fields. Hopi dune fields were stripped of natural vegetation, deep-plowed, surface-packed, and then harrowed after each rain (Hack 1942:32). These tactics for remedying the lack of moisture relied on technology unavailable in the twelfth century. Many of the Wupatki alignments are oriented to provide protection from winds (Brown 1996:39), but there is no indication that they represent the degree of labor investment documented for modern Hopi fields.

The rock alignments may also be misleading because of a “hypervisibility” problem. Hypervisibility occurs when ephemeral and/or minor activities produce highly durable and visible archaeological remains. Figure 4-B shows an ethnoarchaeological example in the Kofyar homeland in central Nigeria. The Kofyar homeland is noted for high population densities and intensive smallholder agriculture (Netting 1968), but this location on a basalt flow had been uninhabited for years. It was covered with long, distinctive rock alignments that might seem to reflect highly active land use. Yet it had been inhabited relatively briefly, during a period of peak population in the early twentieth century. Population spilled onto the basalt-derived soils where rocks had to be cleared to make room for cultivation; the rocks were placed in lines as they were pulled from the fields. Farms on the basalt flows were promptly abandoned when new lands opened up. From an archaeological perspective, they are hypervisible remains of a short-lived practice from a period of an extreme population peak.

It is likely that Wupatki’s many rock alignments are archaeologically hypervisible remains that reflect very little labor investment. This is consistent with the argument that conditions of agrarian ecology at Wupatki left Boserupian intensification a poor, indeed maladaptive, response to population influx. Although there may have been limited instances of rising investment of agricultural labor, a more effective response than intensification would have been to undertake strategies for preserving, or if necessary expanding, the land base for extensive agriculture. Rock alignments, for instance, more likely served as “perimetric features” (Stone 1994), or visual claims to use-rights. An excellent example of this is documented at Wupatki, where an L-shaped alignment, measuring over 150 m on a side, neatly demarcates a prehistoric field system of more than 30 shorter rock alignments (Brown 1996:36).

Sullivan suggests a similar function for many of Wupatki’s small sites: “Conceivably, many of the one-room structures, especially those with few or no artifacts, may be the remains of markers... that were designed to minimize ambiguity pertaining to use of the monument’s agricultural commons” (Sullivan 1994:199; also see Kohler 1992). Yet the extent to which land served as agricultural commons is open to question. With rapid immigration, and the stakes high for secure access to undeveloped or unclaimed land, there would have been a high premium on developing organized, proactive methods of supporting land claims. We propose that this was done on a group basis, which suggests an interpretation of the advent of large pueblos.

**Ethnicity, Consolidation, and Land Control**

Given the impracticality of Boserupian intensification as a response to population influx at Wupatki, farmers had to maintain reliable access to enough land to mitigate the risk of failure: not intensifying but protecting and expanding access to extensive farming. As population growth endangered access to land in diverse localities, strategies for maintaining control over land—including land not in crops at the time—would have become vital. “Improvements” such as hedges, alignments, or fieldhouses depend on shared concepts of property rights; they help little when competitors do not recognize one’s right to be on the land in the first place or are willing to seize one’s land despite ownership claims. Land access must be mediated through social and political channels, and such a situation favors a sociopolitical entity able to back land claims by force or threat. This would create a strong impetus for consolidation—meaning the merging of social units into a larger and stronger unity, alliance, or polity. We propose that there was consolidation of Wupatki sociopolitical entities to provide legitimation of, and backing for, claims to land. These entities would have served to capitalize on the strength of numbers and to recruit additional members.

An important aspect of consolidation into groups is that the formation of one promotes formation of others, much as Flannery described (1972:49) in his analysis of the origins of villages. Initial use of group-based land claims could have stimulated a like response by others. The mid-twelfth century may have seen something of a positive feedback loop, with the Wupatki Pueblo and Citadel groups becoming increasingly consolidated and recruiting members, both from within the monument area and from outside.

It may seem perverse for residents to attract more settlers as a response to rising land competition. But agrarian landscapes are composed not simply of numbers of humans and acres of land, but also of human groups, and land competition is often organized along group lines. There may then be a premium on enlarging one’s group, even if it means more mouths to feed. As Berry (1993:104) wrote for Africa, “to muster sufficient authority to exercise and enforce exclusive land rights... landholders seek, inter alia, to expand the number of their supporters. Authority, in other words, rests partly on inclusionary strategies.”
Population growth can therefore be a tool for securing access to land when the cost of each added adult is outweighed by the added gain in the group's ability to ensure land access.

Recruitment of co-ethnics is common on frontiers (Stone 1996:140–144), and it is easy to propose that pueblo-building and consolidation of sociopolitical entities at Wupatki was shaped by ethnic affiliations. Specifying the precise nature of "ethnicity" is more difficult. Wupatki sites yield ceramics indicative of three archaeological "cultures": Sinagua (indicated by Alameda Brownwares), Kayenta Anasazi or Ancestral Pueblo (Tusayan Graywares), and Cohonina (San Francisco Mt. Graywares). Despite the relatively high degree of population mobility in the twelfth and thirteenth centuries, territorial patterning in material culture can be discerned in the three types of sites. Figure 5 shows the location of more than 1,000 known sites in and near Wupatki at which the dominant plainware accounts for over two-thirds of the plainware assemblage. Other traits, including architectural styles, settlement layouts, and burial practices, further serve to distinguish separate traditions. The ashfall area is located roughly at the southern edge of Kayenta territory, the eastern edge of Cohonina territory, and the northern edge of Sinagua territory. The key sites in the Wupatki and Citadel clusters are associated with distinctive configurations of material culture linked to specific territories. At Wupatki, more than 70% of the plainware pottery is Sinagua, and Cohonina pottery types and architecture are virtually nonexistent. Sites in the Citadel cluster have revealed burial practices and pottery types affiliated with the Cohonina and other prehistoric cultural traditions to the west (King 1949).

The extent to which these were ethnically differentiated groups, especially at the beginning of the Wupatki influx, is unknown. The nature of ethnic boundaries in aboriginal America varied enormously, and groups ranged from those with shared language and culture but no overarching identity or political organization (as in the Great Basin and northern California) to those in which political organization united quite distinct cultural subgroups (as with the Iroquois; see Cornell 1988). The nature of ethnic distinctions also changed through time. The archaeological labels...
of Kayenta, Sinagua, and Cohonina surely do not correspond to unambiguous ethnic groups, yet the spatial patterning in ceramics and other traits (Colton 1946) does indicate separate networks of interaction that would have served as a basis for consolidation of entities centered at the Wupatki and Citadel clusters. Consolidation of land-control polities offers at least a partial explanation of settlement aggregation at Wupatki.

### The Role of Aggregation

Altschul (1978) has suggested that large aggregated pueblos served to establish control over land. Although he was writing of Chaco Canyon, his idea may actually fit the Wupatki case better. Travis (1990:53) writes that

> While some might interpret agricultural intensification as an artifact of increasing stress and risk, an alternative view might explain the same phenomena as a result of communities locked in a competitive struggle for control of regional political and/or exchange systems.

We suggest that the two views noted by Travis are not “alternatives” but cause and effect: the competitive struggle for political control developed principally because of stress and risk, specifically the virtual impossibility of Boserupian intensification. Large pueblos would have provided a material manifestation of the group and may have acted as headquarters.

Two major communities appear to have grown throughout the A.D. 1100s. One was centered on Wupatki Pueblo, comprising over 100 rooms, located in the low-elevation Wupatki Basin; the other was centered on Citadel Pueblo, comprising over 50 rooms, in the upland zone some 10 kilometers to the northwest. Each consisted of a cluster of relatively large pueblos within a few kilometers of Wupatki and Citadel, respectively. Farming conditions around the Citadel group were slightly better than in the Wupatki Basin but were still marginal. Each community apparently grew rapidly during the mid-1100s, probably by in-migration rather than by natural population increase (Burchett 1990; Downum and Sullivan 1990).

These pueblos would have acted as highly visible public representations of group authority; in other words, as monuments (Figure 6). The daily operation of the land-control groups and their monumental pueblos would have been a matter of marking land, making a show of local dominance, and arguing over land tenure, but with the important ability to threaten as a group.

Neither the consolidation of ethnic/political entities nor the creation of large pueblos necessarily required major changes in residential patterns. It is quite possible that only a small portion of the Wupatki and Citadel communities used these large pueblos as primary residences; others could have kept formal residences in or near the large pueblos while actually spending much of the year at smaller sites near areas they farmed (for ethnographic examples see Stone 1996:48–51). There is evidence of year-round residence even in the smaller pueblos (Colton 1946; King 1949). Nor does development of land-control polities necessarily mean that the land-control group act as a production or food-sharing unit. A group may be united in sharing designs on a territory without sharing household-level production from plots within the territory.

### Population and Territoriality: An African Analog

An example from Asamu, in the savanna of the Benue Lowlands of central Nigeria, illustrates the political dynamics of land-control groups. This agricultural frontier has received continuous population influx in recent decades, as described by Stone (1997). Unlike Wupatki, this area offers Boserupian conditions: with rising population (and also market demand), production concentration has been raised in many areas, although at a considerable cost in labor. But it provides a partial analogy because there have also been concerted efforts to control land instead of intensifying. Furthermore, Asamu is a polyethnic frontier with rising population, where land access is negotiated along ethnic group lines, largely outside of the reach of the state.

Asamu has come to be the scene of simmering—and occasionally overt—hostility, organized along ethnic lines and stimulated by land competition. Tiv first appeared in this area, well north of the Tiv heartland, around 1939. By 1945 Tiv had built the hamlets of Ukwese, Tse Uche, Utume, and Shamga, all of which are still inhabited. The Tiv claim the entire area shown in Figure 7, although they argue among themselves over boundaries. Other, smaller Tiv settlements have appeared as satellites to the 4 major hamlets, farming with permission. By 1994 (when G. Stone and R. Netting did fieldwork there), there were 8 Tiv settlements, ranging in size from the small single-household satellite settlement of Bende (pop. 6) to the village of Utume (pop. >300).

The hamlet of Ukwese had 13 households and a population of 212 in 1994, each with its own holdings within the 4.2 km² controlled by the village. Ukwese held 5.3 km² in 1972, but its territory has been encroached on several fronts as agricultural immigrants moved into the area. While some of the non-Tiv immigrants have adopted intensive agriculture, with up to 75% of their holdings in cultivation, the Tiv have mostly sought other solutions. As their per capita land base has dwindled, they have increasingly turned to a campaign of intimidation, designed to reverse the influx of non-Tiv population. Collaboration is a key to this campaign: the separate households of Ukwese are united in agitating to protect Ukwese land, although they do not cultivate it communally. Indeed, there have been some sharp disputes within Tiv villages over land...
rights, but in reaction to encroachment by non-Tiv immigrants these differences have faded and the villages have become more consolidated.

Tiv explicitly use the settlements themselves for intimidation. By design, Ukwese and Utume straddle the main road through the area, while Tse Uche is positioned immediately adjacent to the road (Figure 7). This contrasts with the smaller settlements of non-Tiv groups (mostly Kofyar and Mwahavul). An elder from Ukwese told G. Stone pointedly, “Everyone who comes this way will see us first.” While the scale is smaller and the appearance different, these villages convey a message similar to what we have proposed for the Wupatki pueblos.

This social response to land shortage has some parallels with the Bohannans’ account of the Tiv heartland (P. Bohannan 1954a, 1954b; Bohannan and Bohannan 1968), although its object is to protect sedentary villages rather than underwrite “predatory expansion” (Sahlins 1961). As in the heartland, Tiv groups rely on a unified front and on the strength of numbers to threaten land competitors and to circumvent the need for serious belligerence. Nevertheless, there have been repeated minor instances of violence (such

Figure 6. Monumental pueblos. Top: Wukoki, a pueblo in the Wupatki cluster. Photo by G. Stone. Bottom: Citadel (Wupatki negative W194). Photo courtesy National Park Service.
as theft and killing of stock) and, in other parts of the region, possible cases of murder.

Conflict and Abandonment

The Tivs' use of ethnic/political land-control entities in response to resource competition, and their reliance on intimidation potentially backed up with violence, exemplifies some aspects of the land-control politics we propose for Wupatki. The main stimulus in both cases is avoidance of agricultural intensification, but the cases differ in the costs and benefits of intensification as modeled by intensification slopes. Tiv have already intensified farming to some degree, and the marginal returns to further intensification would not be disastrous (as their Kofyar neighbors have shown). The Tiv also have relatively good opportunities for emigration, and there is much coming and going of households and household fragments in the Tiv villages. For Wupatki farmers, the intensification slope drop-off was much more precipitous; reliance on a dwindling land base would have been not only onerous but extremely risky. Emigration from the enhanced conditions of the ashfall zone would not have been appealing. A better strategy at Wupatki, at least in the short term, was to invest effort in land-protection strategies, including the building of monumental pueblos. Because the agrarian ecology at Wupatki offered little reward for off-season work—principally because the limitation to agriculture was water, and irrigation was largely impossible—the opportunity cost of nonagricultural work in the off-season would have been low. Time would have been better spent contributing to the consolidation and reputation of the polity protecting property rights than working on field improvements. An additional activity apparently was craft production and exchange (Stanislawski 1963), some of which involved commodities such as clothing and personal ornaments that may have been used to signal ethnic identity and status (Folb 1996; Schneider 1987).

Some investment of time and effort into physical intimidation would have been strategic as well, at Wupatki as at Asamu. There is no doubt that there was violence at Wupatki, including gruesome cases of dismemberment and burning of body parts (Smith 1952:20; Stanislawski 1963; Turner and Turner 1990). The frequency of physical brutality is an interesting question. There is renewed debate about violence throughout the northern Southwest, and there is now convincing evidence that conflict was more widespread and vicious than previously understood (Hurst and Turner 1993; Turner and Turner 1999; White 1992; Wilcox and Haas 1994). Yet the abundant archaeological evidence of a well-developed agricultural landscape suggests that daily life at Wupatki was not crippled by unchecked aggression. While the archaeological record shows that violent incidents occurred, we propose that aggregation into large and highly visible pueblo structures provided an effective implied threat of retaliatory capability that seldom was exercised. We suggest that the people attached to Wupatki's large pueblos were neither inveterate cannibals (cf. Turner and Turner 1999) nor organized into militaries (as in Carneiro's [1970] model of sociocultural evolution); a better characterization would be ethnic groups jockeying for the upper hand in territorial control, occasionally resorting to small-scale terrorism with much spectacle to maximize the effect.

Although group-based land control at Wupatki would have been advantageous in the short run, it may have been unstable in the longer term. Attracting population would only have exacerbated the problem of land availability through time, leaving farmers increasingly vulnerable to climatic fluctuations. Sullivan points out (1994:201; see also Cinnamon 1988) that by A.D. 1220, "cinders had drifted from fields ... ponds had dried up ... trees had been cut down ... and the local faunal base virtually exterminated." The dramatic mid-thirteenth-century abandonment of the Wuptaki area cannot be explained by climate or "habitat destruction" alone (cf. Sullivan and Downum 1991). In light of our proposed model and current evidence from Wupatki, the abandonment makes more sense as the environmentally triggered result of unintended long-term
consequences of ethnic/political strategies for land control, strategies set up as a response to a non-Boserupian intensification slope.

Despite the unique elements of the Wupatki case, such as the ashfall and the location at an ethnic frontier, it is also part of a widespread pattern of pueblo aggregation in the Southwest during the twelfth and thirteenth centuries. These aggregations occurred in conditions of widely varying agroecology, and our proposed mechanism of territorial control to protect extensive agriculture under non-Boserupian conditions would not fit all cases. For instance, Adler sees other aggregations near Mesa Verde as playing a key role in territorial control, although for a different reason: farmers in that relatively well-watered region were intensifying and thus were exerting "increasingly formalized and codified controls" over resource rights (1996:361).

Discussion

The larger conclusions from this study concern general models of agricultural change. The Boserup model has had few equals as an influence on social science in the past 30 years, but it has also attracted highly diverse criticisms. We have noted three general objections. The first repudiates the model on the grounds that it is a "progressive, stepwise classification of cultural types" (Morrison 1996:584), that is, more evolutionary than is currently fashionable. We note above that the actual effect of the model has been more as an antidote to evolutionary interpretations of agricultural change. The Wupatki case study suggests an even more ironic relationship between Boserup and evolutionism, viz.: that there was consolidation of political (land-control) entities because of the impossibility of Boserupian intensification.

The second complaint concerns the many factors Boserup held constant in her generalized model. The present study also concerns such factors, placing heavy emphasis on the local agroecology that Boserup neglected and proposing nonagricultural responses to population pressure. Explaining why land control would have been favored at Wupatki forces us to reconceptualize the relationship between agricultural productivity and efficiency and to recognize Boserupian intensification as a process that occurs only under specified (albeit common) circumstances. In other words, this study delimits rather than discredits the Boserup model and thereby aims at a more positive contribution to theory building.

This reconceptualization also addresses the final complaint, concerning the cases where Boserupian ecology simply does not fit: production concentration can be raised without a penalty in proportionate workload, or production concentration does not rise despite increased workload. As an example of trajectory B, Wupatki is a setting in which we should not expect Boserupian intensification, and our review of archaeological evidence concludes that intensification probably occurred only in highly restricted contexts. Agriculture had, by necessity, to remain extensive, and societal adjustments were aimed at preserving the ability to enforce access rights. As more mouths arrived in the area and had to be fed, unused or unclaimed territory had to be claimed and territorial boundaries enforced.

Such responses are not unique to non-Boserupian agroecological settings. Indeed, for a modern illustration of proactive group-based land control we used Tiv farmers from a setting offering classic Boserupian conditions and some well-documented cases of intensification. Understanding the different responses to population pressure requires relaxing Boserup's assumptions; the Tiv would agree with Boserup's model of increasing costs of intensification, but not with its inevitability. Wupatki is different, an example of non-Boserupian conditions where, except in a very few places, Boserupian intensification is simply not an option. As risk rises and production concentration cannot be raised, responses must occur not in agricultural tactics but in sociopolitical strategies for circumventing increased production concentration.

Notes

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1. "Wupatki" here refers to the area in and around Wupatki National Monument (including Big Hawk Valley, Antelope Prairie, Lower Deadman Wash, Wupatki Basin, and White Mesa) rather than the large site known as Wupatki Pueblo, or even the exact boundaries of Wupatki National Monument itself.

2. Netting (1993:271n) defined intensification simply as raising land productivity by technology and/or labor. He writes that the "efficiency of labor—that is, the return on each unit of labor input—must be empirically determined, and it does not necessarily decline under all processes of intensification.” We agree that raising land productivity need not lower efficiency in all situations but maintain that this is an indispensable element of the process Boserup described. This is why it is necessary to distinguish Boserupian intensification from responses to non-Boserupian conditions.

3. Folb (1996) concludes that the alluvial zone was used principally for high-value crops such as cotton.

4. As Adams and Mortimore point out (1997:152), “Flexibility is an indigenous response to environmental risk, and it offers freedom of manoeuvre that is lost in the process of intensification. Loss of flexibility is, therefore, one of the costs of intensification.”

5. In isolating what happens when population density rises in a given locality, the Boserup model neglects population
movement as a response to land pressure. The spread of population from where landscape modifications are optional to where they are necessary therefore lies outside the scope of her model. Stone (1996:52–53) describes this process as locational intensification.

6. What Travis categorizes as “composite fields” probably represent no particular agricultural phenomenon; they probably reflect admixtures of other field types. These may have resulted from changing uses as described in Doolittle’s (1984) incremental change model.

7. This holds true also for the fieldhouses that dot the Wupatki landscape. While these may have had utilitarian functions, such as housing for field guards or temporary storage for harvests, their primary value was probably as markers (Kohler 1992). The marker function would have been less needed in Hopi fields, with a more stable sedentary population and established ownership of fields (Whiteley 1985).

8. See Rautman (1993) for a discussion of how large-scale social networks can function to mitigate risk.

9. Kayenta Anasazi material culture is represented in sites of both clusters, and indeed Wilcox (1994:25–26) attributes the monument’s settlement entirely to Kayenta. We do not believe that present evidence allows a reliable reconstruction of how Kayenta related to Cohonina and Sinagua, but it does indicate a cultural divide of some sort between the Citadel and Wupatki clusters.


11. Nigerian law assigns ownership of all land to the state, but relinquishes control of undeeded land to “customary tenure.” Land access is mediated, sometimes with violence but often without, through the jockeying of groups to establish themselves in local areas. Courts play virtually no role in mediating disputes.

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