

Dry-Season Flood-Recession Rice in the Mekong Delta: Two Thousand Years of Sustainable Agriculture?



JEFF FOX AND JUDY LEDGERWOOD

THE MEKONG DELTA is famous as the hearth of one of the earliest civilizations in mainland Southeast Asia. Called “Funan” by visiting Chinese dignitaries, the lower Mekong Delta housed at least two urban centers by the third century A.D.: Oc Eo in current-day Viet Nam and Angkor Borei in Cambodia (Coedès 1931; Jacques 1979; Mabbett and Chandler 1995). Brief examination of Oc Eo in the early 1940s (Malleret 1959–1963) revealed a complex system of water control, monumental architecture, and a rich material culture. Little is known about the subsistence or economic basis of the Funan civilization, and its location in the Mekong Delta poses a paradox for understanding human colonization of the area. The delta is an uncomfortable environment for human survival. Today’s inhabitants are forced to live in their houses and on their boats for four to five months a year when the river floods; natural vegetation, including both freshwater mangroves and riverine forests, is dense and difficult to control; and drinking water is scarce in the dry season. Yet this same environment is also exceedingly fertile because of the annual deposition of silt laid down by the retreating floods.

This paper describes current land-use practices in and around Angkor Borei, as well as practices found in the recent past, and hypothesizes on the relative antiquity of these practices with respect to early state formation in the region. Dry-season flood-recession rice, the major land use in the area, is an ancient land-use system that, taking advantage of the fertile silt deposited by the annual floods, is both extremely productive and sustainable. In modern times, Cambodian farmers grow dry-season flood-recession rice in areas where the maximum height of the annual flood exceeds 3 m (too deep for most rice varieties), or where the flow of water is very rapid, making it risky to plant floating rice (a variety adapted to slow, regular flooding with stalks that reach 5 m long) (Delvert 1961:331). Flood-recession farmers store floodwater in bunded areas and man-made reservoirs and then release this water to supply paddies situated below the bunded

Jeff Fox is Director of the Program on Environment, East-West Center, Honolulu. Judy Ledgerwood is an assistant professor in the Department of Anthropology, Northern Illinois University, DeKalb.

areas during the dry season. If conditions permit, farmers prefer to grow flood-recession rice, because yields are higher in comparison both with floating rice and with transplanted wet-season rice due to the enhanced fertility of the silt deposited by the floods.

The low-lying Angkor Borei basin allows the rising floodwaters of the Tonle Bassac (Bassac River) to spread out across the landscape and diminishes the impact of the flood on any one site. Thus, like its counterpart to the north, Tonle Sap (the great lake), the Angkor Borei basin is a natural mechanism for the renewal of soil fertility. We suggest that dry-season flood-recession rice was the land-use system that supported Angkor Borei and the Funan polity in the second to sixth centuries. Furthermore, we hypothesize that the system of dry-season flood-recession agriculture was adopted elsewhere in the delta either in advance of or in congruence with other lower Mekong polities (e.g., Chenla and Angkor). If this hypothesis proves true, then dry-season flood-recession rice has played a much larger role in the early history and culture of the lower Mekong Delta than has been appreciated by students of the region.

Van Liere, writing on traditional water management in the lower Mekong basin, describes the landscape morphologies and the types of rice farming that developed in response to these landscapes.

First, there is the channel or channels of the main river, with adjacent levees or riverbank deposits. Then, behind the river banks, are the back swamps, connected with the main channels by distributaries and acting as natural flood regulators when the monsoon river rises rapidly. Back swamps are very common in the lower Mekong basin. They vary greatly in size, the largest being the Great Lake in Cambodia, which covers one million hectares when the Mekong is in flood. Around the back swamps are the alluvial plains and low terraces. Alluvial plains are intermittently flooded in the rainy season, while the low terraces are normally not flooded at all (van Liere 1980:266).

Table 1 summarizes the landscape systems found in the lower Mekong basin, the land uses historically associated with these systems, and estimated rice yields for each system. Floodland farmers (van Liere 1980:267), found primarily in the

TABLE 1. LANDSCAPE AND LAND-USE SYSTEMS IN THE LOWER MEKONG BASIN

LANDSCAPE MORPHOLOGY	LOCATION	LAND-USE SYSTEM	ESTIMATED RICE YIELDS (tons per ha)
Alluvial plains	Mun-Chi River basin, northeast Thailand	Floodland farmers (wet season)	1.2 to 1.6 ^a
Low terraces	Lowlands above the Tonle Sap, Cambodia; and Mun-Chi River basin	Bunded-field farmers (wet season)	0.6 to 0.8 ^a
Back swamps	Basin of Angkor Borei, the basins behind the banks of the Tonle Sap, and the depressions along the banks of the lesser and greater Tonle Thom Rivers	Receding-flood farmers (dry season)	2 to 3 ^b

^a Estimates from Stargardt 1983.

^b Estimates from Lando and Solieng 1991.

Mun and Chi River valleys in northeast Thailand, preferred the alluvial plains watered by natural flooding, where the floods rise and fall gradually and where the floods are not too deep. These farmers utilized the natural rise and fall of the river to plant rice during the wet season.

Bunded-field farmers (van Liere 1980 : 271) reclaimed large areas of low terraces found behind the alluvial plains. The rice grown on bunded fields is transplanted from nursery beds and watered by wet-season rainfall.

Receding-flood (dry-season) farmers (van Liere 1980 : 272) were found in the back swamps around the Tonle Sap. These farmers retained floodwater in bunded areas and then used it to supply paddies situated below the swamps during the dry season.

Stott (1992 : 54), drawing on van Liere's work, argues that it is now apparent that the perfection of dry-season flood-recession rice was the real economic basis of the greater Angkor Empire (A.D. 802/50 to 1423/31). More recently, Ang Choulean et al. (1996 : 152) acknowledged the unique phenomenon of Tonle Sap and the important role the lake played in the dry-season flood-recession rice system and thus for food production for the inhabitants of Angkor. While van Liere does an excellent job of describing flood-recession rice and building the case for its role in the Angkor Empire, he did not consider its importance in earlier lower Mekong civilizations. In this paper, we argue that dry-season flood-recession rice and not wet-season irrigated or rain-fed rice made cultivation possible in this deltic environment.

METHODS

This project used an interdisciplinary approach to develop a database that blends information from fieldwork and interviews, topographic maps, aerial photographs, and satellite images. We used a Geographic Information System (GIS) to integrate information at the spatial scales necessary to link site-specific land use to archaeological remains and to further our understanding of settlement patterns at the regional level of the landscape. Contemporary resource management practices were documented, including types of management activities employed by local people to produce, extract, protect, or manage their resources. Ethnographic techniques were utilized to study the social and economic causes and consequences of environmental change at village, district, and provincial levels. We conducted approximately 40 semi-structured interviews with local key informants and farmers. We also reviewed secondary sources to generate information on changes in national and provincial policies and social economic changes at the village level. Household interviews focused on current land-use patterns, sectoral variations, and village social organization. Site survey techniques included on-ground inspection, and identification of sites through examination of aerial photographs and LANDSAT images.

RESULTS

Geography of Angkor Borei

Angkor Borei lies on the western edge of the Mekong Delta at 10°59' N and 104°58' E. A LANDSAT image (January 1995) clearly shows Angkor Borei anchored securely to dry land on the northwest and surrounded by the low-lying

delta in all other directions. French geographer Etienne Aymonier (1900) calls this location the interstice between the most southern edge of the Cambodian plateau and the Mekong Delta. The basin begins approximately 30 km to the north of Angkor Borei where the Prek Ampil (*prek*, stream or canal) branches off the Tonle Bassac. The Prek Ampil continues to flow under various names in the flood plain, parallel to the Bassac channel until it emerges under the name of Song Chau Doc. It is joined by the Steung Takeo at Vinh Hoi Dong and continues in one channel to a junction with the Tonle Bassac (called Song Hau Giang in Viet Nam) at Chau Phu. At stages below flood, this channel carries a flow of about 40 percent of the Tonle Bassac. Above flood stage, the overbank flow continues as a sheet of water to the west and south (the Angkor Borei basin). For four to six months of the year (August through January), large portions of the basin are flooded, and residents step from their houses (built on stilts—or as the third-century Chinese sources say, “wooden houses raised on piles” [Wheatley 1983: 123]) directly onto boats tied up outside their doors.

Figure 1 shows the city walls encircling an irregular or D-shaped city with a perimeter 6 km long enclosing an area of approximately 300 ha. The city wall is surrounded on four sides by a *kou*, a drainage ditch or moat. The ancient hydraulic system also included reservoirs inside and outside the city wall. The reservoirs and the moat trapped river- and rainwater to regulate the seasonal inundation and to store water for use in the dry season.

The area to the northeast of the city wall lying between two rivers (see Fig. 1), Steung Angkor (one of the names for Prek Ampil) to the west and Steung Sandek to the east, is called the *kaoh* (island) and is one of the community's major rice-producing areas. The canal or stream running west-southwest from the city wall is known as Prek Chik (dug stream) and is a man-made feature that farmers believe is the same age as the wall and moat.¹ This canal was probably built to drain water away from the city. In doing so, however, it carries water to the area south of the city wall, creating another floodplain, between Prek Chik and Phnom Angkor Borei. This area is not as large as the *kaoh*, but it is an important source of rice production. More recently, the areas south of Phnom Da and Phnom Angkor Borei have also been put into flood-recession rice production since the digging of canals by people during the Pol Pot regime and the introduction of gasoline-driven water pumps.

The question arises, have there been any significant changes through the past 2000 years in the location of Angkor Borei relative to the wet and dry portions of the delta and to the major rivers, the Bassac and the Mekong? The fact that the city is still located at the interstice between the southern edge of the Cambodian plateau and the Mekong Delta, as well as the fact that the Steung Angkor still flows through the heart of the city, suggest that the relative position of the city in relation to the major water bodies and the delta has not changed through time.

Current Land-Use Practices

Farmers begin plowing their fields in June after the first rains and then leave them to be flooded. In Angkor Borei, farmers clear the fields of floating weeds when the receding floodwater is 0.5 to 1 m deep. Seedbeds for transplanted rice are planted in December. In January, as the floodwaters recede further, farmers begin

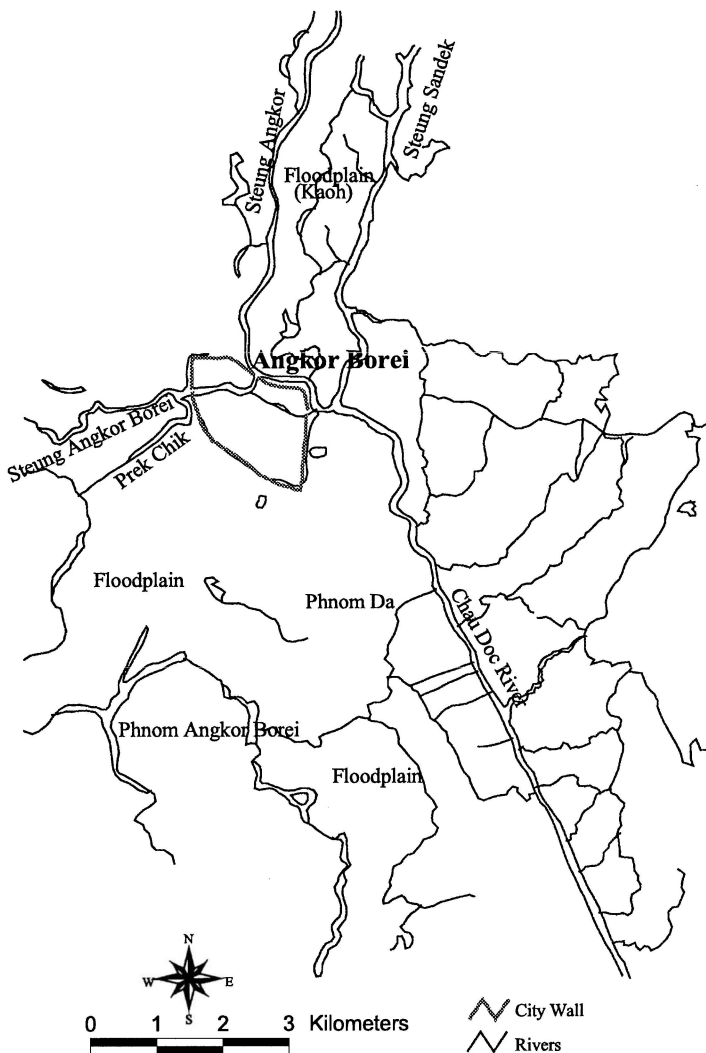


Fig. 1. Angkor Borei and vicinity in the Mekong Delta, Cambodia.

to plant the rice crop. In low-lying areas, they transplant (*srauv santoung*), and in higher areas they broadcast (*srauv pruos*). Both broadcasting and transplanting can occur at the same time, and involve the same rice varieties (today, all farmers plant short, 90-day rice varieties). The lowest lying lands are often used for transplanting glutinous rice (*srauv doemnaoep*). From plowing to transplanting takes six to seven months. After the rice is planted, farmers weed the fields.

Approximately five or six days after transplanting, farmers begin to pump water to their fields from a series of man-made *boeng*, as well as from natural water features (*trapeang*). Near the rivers and canals (both ancient and modern), water spreading is achieved by means of a multitude of small ditches. These ditches are quickly made and easily blocked, when necessary, and quickly removed or changed. On average, farmers pump water once every five to seven days for three

months or until the grain begins to ripen. Approximately 15 to 20 days after they stop irrigating their fields, farmers can begin harvesting. Harvesting usually occurs in March, and after the harvest, fields are then left fallow until they are plowed again in June.

Farmers generally use chemical fertilizers only in their flood-recession fields. Delvert (1961) argues that this is because these fields are too far from the home to conveniently use manure or organic fertilizers. Most farmers spread chemical fertilizers three times during the growing season: when they transplant or broadcast; when the rice is 8 to 10 cm tall; and when the grain begins to fill. Farmers report that broadcast rice needs more fertilizer than the lower-lying transplanted fields, perhaps because the lower-lying fields receive greater deposits of silt. A growing numbers of farmers are also using insecticides. Farmers spread insecticides approximately one month after planting.

All but a few farmers use oxen to plow their fields. It takes a set of oxen six to eight mornings to plow a hectare field. Farmers who do not own oxen pay others to plow for them, at approximately 70,000 riel (US\$28) per hectare. Plowmen will often work together in teams of six or more pairs of oxen, to finish plowing a hectare field in a single morning. One farmer had recently bought a motorized hand plow and was charging 80,000 riel (US\$32) to plow a hectare field.

Most farmers hire day laborers to assist them in transplanting and harvesting their fields. And many farmers will hire themselves out to do these chores when it is too early to do their own fields or after their own fields are completed. On average, it takes 30 or 40 people one day to transplant a hectare field. Harvesting takes fewer people. Lando and Solieng (1991) argue that in villages where farmers depend on wet-season lowland rice for subsistence, owners of plow animals seldom plow in others' fields for cash payment but only in exchange for labor. Likewise, that cooperative labor is the basis for access to agricultural labor in the fields. But in the nine communes where Lando and Solieng studied dry-season rice production, they found, as we did in Angkor Borei, a similar emphasis on hired labor and hired animal power. Several farmers suggested that this is because timing is too critical in flood-recession systems to make labor exchange systems possible.

We conducted semi-structured household interviews with several farmers. While we never intended to collect data in a quantifiable manner or from a random sample of farmers, these data tell a story that appears to be roughly accurate. An average household is composed of five to six people and owns 1.4 ha of land yielding 2.5 tons of rice per ha. Farmers on the *kaoh*, where land is more fertile because of deeper silt deposits, as well as farmers with land along the Song Chau Doc, where flood-recession rice has been practiced only since the building of modern canals during the Khmer Rouge period, report yields of 4 to 5 tons per ha. Overall, the District Agricultural Office estimates 3 tons per ha, significantly higher than the national average of 1 ton per ha. All farmers in this sample planted flood-recession rice in the dry season. Most farmers planted IR 66 or HB 66 varieties, although some households mentioned traditional varieties as well. Five of the nine households interviewed had surplus rice production to sell in the market. These households sold an average of 2,700 kg of rice, which at 3,500 riel (US\$1.40) per *tao*² (12 kgs), would be worth approximately 725,000 riel (US\$290). Two-thirds of the households had their own pump and used chemical fertilizers; one-third used pesticides, and about half kept a pair of oxen.

According to the Angkor Borei District Agricultural Office, in 1995 farmers planted 7,675 ha of flood-recession rice and only 3,878 ha of wet-season rice. The biggest agricultural problems in the district were insects, rats, and water supply (irrigation) for the higher lands.

Some farmers have small gardens around their houses, with a variety of fruit trees and a few vegetables. Fruit trees include orange, mango, jackfruit, and *longan*. Vegetables grown often include chilis, cucumbers, bittermelons, watermelons, pumpkins, beans, and taro. Farmers on the margins of the flood-recession areas must choose to either plant wet season or dry season rice; they cannot grow both. If they choose to grow wet season rice, then they face the double jeopardy of insufficient water if the rains are late or losing the crops to floods if heavy rains come too soon.

Delvert (1961) noted that in the late 1950s, this area was renowned for its livestock. Today, most farmers still keep livestock. As previously mentioned, about one-half of the farmers we interviewed kept a pair of oxen for plowing. Oxen are also kept for meat production. Almost all villagers keep pigs and chickens. Pigs are raised for the market, and chickens for home consumption. Pigs and cattle are marketed in Viet Nam, but this is illegal. Although prices are low, livestock are also marketed in Takeo town and in Phnom Penh. Farmers reported that while many people do get around the legal restrictions on selling livestock to Viet Nam, these restrictions pose a serious disincentive to raising livestock today.

Delvert (1961) likewise noted that Angkor Borei was also renowned as a dry-season fishing site (February through June). Today, villagers can legally fish from February through March, and rights to prime fishing spots are leased out. A fisherman caught fishing illegally in a leased zone may be fined 5,000 riel per day. Large fish can be sold in Phnom Penh, and small fish are sold in Viet Nam and locally. Today's legal constraints on fishing appear to pose serious disincentives and even economic hardship on small farmers (whether the constraints are ecologically based is not known).

Villagers have traditionally cut firewood from brushlands south of the city walls. In June 1995, we observed groups of young women riding their bicycles out to Phnom Da and Phnom Angkor Borei to cut thornbushes growing on land that was not yet claimed (or reclaimed) for flood-recession rice. In 1996, many of these areas appeared to have been cleared and plowed. Firewood, however, was still available along the bunds of the Prek Chik canal, along roads, and around the foot of the mountains.

Land-Use Practices in the Recent Past

In interviews with older farmers, we asked them about land-use practices when they were children. In a few instances, this provided us with a glimpse of land-use practices in the 1940s and 1950s. Although the basic pattern of flood-recession rice has remained stable, there have been a few significant changes. Until recently, farmers grew local varieties. The most-mentioned varieties were *srauv Andai* and *srauv Angkock*. These varieties have a growing period of 120 to 130 days, a height of approximately 120 cm, and reportedly yielded approximately 2 tons per hectare. Height is perceived to have been the chief advantage of these varieties, as they tolerate deeper standing water than the newer, high-yield varieties, but

height also made these varieties more susceptible to lodging, or falling down in the field. Farmers also reported rice varieties with 200- to 240-day duration. Today, no one reported currently planting any of these 120- to 240-day varieties.

Farmers on the *kaoh* mentioned planting “floating” or “deepwater” rice (*srauv brapeayueavea*) in the wet or flood season. In 1995, the floods were larger than expected, and the crop was lost; thus in 1996, no floating rice seed was available. Farmers claim that many floating rice varieties have been lost over the past several decades.

Traditionally, flood-recession rice was grown on low-lying fields, which could be mechanically irrigated with traditional water-lifting devices, such as the water shovel (*snach*) or the pedal driven irrigation wheel (*rohah*), using water channeled from a storage source. Since 1980 all farmers have converted from these traditional devices to gasoline-driven pumps. As mentioned above, two-thirds of the households we interviewed owned their own pumps, and the others rented pumps from their neighbors.

At least on some fields, plowing (with oxen) is a new technology introduced within the lifetime of current inhabitants, and even today, farmers say if they do not have enough money to pay for plowing, they plant anyway. This is consistent with Lando and Solieng (1991: 17), who observed in Srey Ampal, Kandal Province, that some farmers cultivate flood-recession rice with zero tillage (no plowing) and staggered timing of transplanting of the fields due to the amount of seasonal flooding on their low-lying fields.

Farmers reported that rice fields used to be smaller, and there were fewer fields because there was insufficient labor to manually pump water to the fields using the traditional water-lifting devices. Until recently, insufficient labor (both human and oxen) and seed rather than lack of land was the major constraint farmers faced. Farmers also reported that because there used to be fewer people and because rice fields were smaller, there used to be more forest and brushland around the village than there is today.

Several farmers reported that they used to grow rice only for home consumption and grew flood-recession maize as a cash crop. Maize was the preferred cash crop because it required less water and thus less labor. Today, however, none of the farmers we interviewed reported growing maize.

HYPOTHESES ON LAND-USE PRACTICES IN THE FIRST CENTURY A.D.

The earliest documentary reference to agriculture in the lower Mekong basin comes from the *History of the Chin Dynasty*, which states that the people “one time plant, three times harvest” (Hill 1977: 16). Hill argues that this statement has been misinterpreted by several writers and suggests there is no evidence of “annually-sown irrigated crops at that time [Funan period] but merely of either a one-year-in-three rain-fed system of rice cultivation with what may be termed a ‘self-fallow’ and collection of ratoon crops or, alternatively, of three years’ cropping of clearings.” The actual physical evidence for rice comes from Malleret (1960: 88), who reported finding blackened rice grains at Oc Eo at a depth of 2.3 m. The *History of the Chin Dynasty* also reported that people built wooden houses raised on piles, and that roofs were thatched with the fronds of “a large bamboo having leaves from eight to nine ch’ih in length” (Wheatley 1983: 123).

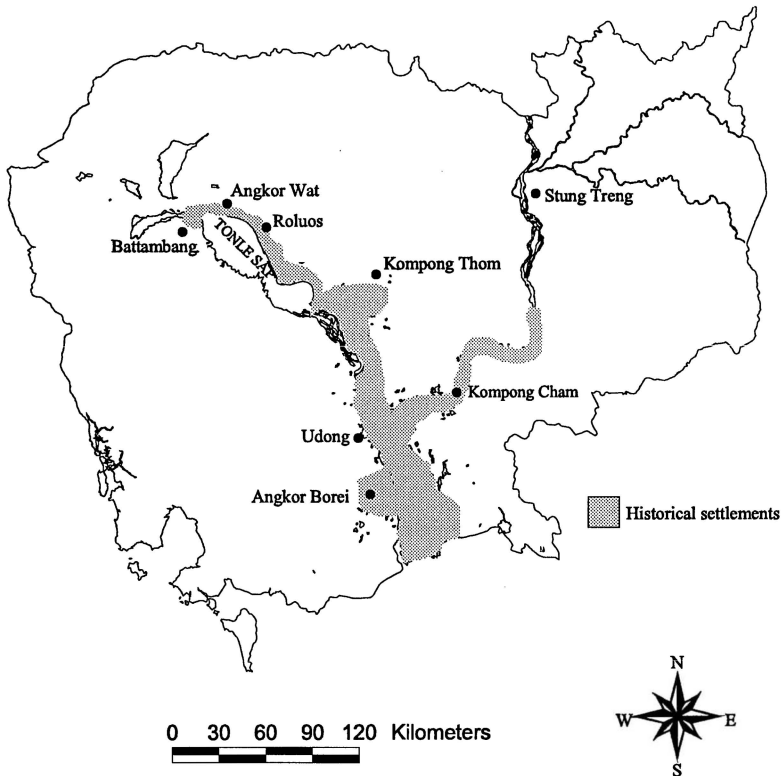


Fig. 2. Early historical settlement centers in the lower Mekong Delta as mapped by Ng (1979: 271).

Wheatley argues this is a clear reference to the palm *Nipa fruticans*, whose pinnate fronds form continuous stands fringing the tidal estuaries of the delta.

Ng (1979: 271) mapped early historical settlement centers in the lower Mekong basin (Fig. 2). These maps correlate closely with Wheatley's (1983: 124–127) description of the sites, where pre-Angkor inscriptions and archaeological sites have been found in the lower Mekong. Interestingly, neither Ng nor Wheatley noticed the correlation between their descriptions of historical settlements in the lower Mekong basin and Delvert's (1961: 332) description of flood-recession rice-growing areas (basin of Angkor Borei, the basins behind the banks of the Tonle Sap, and the depressions along the banks of the lesser and greater Tonle Thom Rivers between Kratie and Phnom Penh) (see Fig. 3). Approximately one-third of the 20 sites Wheatley lists as having pre-Angkor inscriptions (Naravaranagara, Adhyapura, Vyadhapura, Tamrapura, Sambhupura, and Purandarapura) fall within the flood-recession rice zone, as well as all but one of the pre-Angkor archaeological sites. Given that dry-season rice accounts for less than 8 percent of the rice land currently cultivated in Cambodia and that dry-season flood-recession rice is even a smaller portion of this (Lando and Solieng 1991), we question whether this congruence can be merely coincidental.

On the basis of current and recent land-use practices, we suggest that dry-

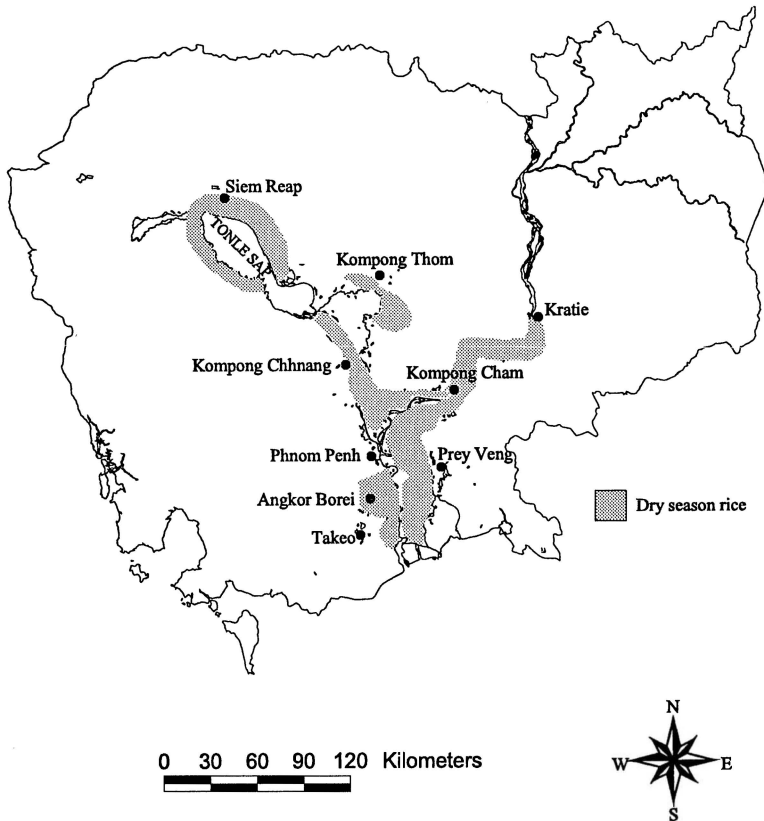


Fig. 3. Flood-recession rice-growing area as described by Delvert (1961 : 332) for the lower Mekong Delta. Note its similar distribution to historical settlements in Figure 2.

season flood-recession rice was grown primarily in small, low-lying fields, where it would have been easier to lift water from the *boengs* to the fields. Floating rice was probably important in areas where floodwaters did not exceed 5 m depth and where farmers did not have sufficient labor to lift the water from the reservoirs to the rice fields. In terms of technology, flood-recession rice requires some type of water-lifting device. Farmers described three types of traditional systems—water-wheels (*rohat*), bucket swings (*snach*), and a balanced scoop (*thleng*). These are all very simple devices, and although there is no proof that they existed between A.D. 1 and 600, there is no reason to believe that they would not have existed.

Today, most farmers depend on plowing the land with oxen and steel-tipped plow. Higham (1989) suggests that one way of accounting for the rise of large, more complex societies in Southeast Asia after the fourth century B.C. is to attribute it to the consequences of the more intensive agriculture made possible with iron implements, particularly plowshares. Although Higham suggests it is very likely that iron implements had much to do with the process of social and cultural change, he also notes that “the chain of cause and effect is not clear.” It is true that the Vietnamese acquired iron plows from their contacts with Chinese cul-

ture, but there is no evidence of iron plows elsewhere in the region. Thus, while again there is no proof that farmers in Angkor Borei had plowshares between A.D. 1 and 600, there is no reason to believe that they did not at least know of them. On the other hand, even if farmers of the delta had knowledge of plowshares for 2000 years, they may have chosen not to use them given the flooded nature of their fields. Even today, many farmers practice zero tillage.

Using LANDSAT land-cover data and a few assumptions, we can calculate how large a population it would theoretically have been possible to support in the Angkor Borei at any point in the past 2000 years. Based on the LANDSAT classification, we estimate that within a 10-km radius of the city, there are approximately 16,000 ha of flood-recession rice.³ If we estimate that this land produces 1.5 ton per ha (actual production today is approximately 3 tons per ha) in the dry season, we have an annual production of 24,000 tons of rice grain. It has been calculated that the total annual nutritional needs of an individual are approximately 200 kgs of food grain per year (Higham 1989:352). This suggests that flood-recession rice production within 10 km of Angkor Borei should be sufficient to support a population of approximately 120,000. In terms of labor, Delvert (1961) estimated that in the 1950s, it took a family of five (two adults and their children) 60 to 80 days of labor to manage 1 ha of dry-season rice (this does not include the labor to lift water from the *boengs* to the fields). This suggests the production of 24,000 tons of grain would require a work force of 80,000 people. This would mean grain production excess sufficient to support a population of 40,000 people not involved in rice production, or approximately 8,000 tons of grain. If the population of Angkor Borei was approximately 80,000 people within 10 km of the city, then the population density was approximately 250 people per km². Delvert (1961:545) reports that in Prey Krabas District (including much of the Angkor Borei basin), there were approximately 200 people per km² in the early 1950s.

TWO THOUSAND YEARS OF SUSTAINABLE AGRICULTURE?

The location of Angkor Borei in the Mekong Delta poses a major paradox. On one hand, the delta is a difficult environment for human survival. In the rainy season, water steadily accumulates, covering the landscape with several meters of water, and in the dry season, the landscape becomes parched and baked. In the rainy season, there is no dry land; and in the dry season, there is no drinking water. Water control systems with high labor requirements for construction and maintenance, such as dikes, bunds, and reservoirs, appear to be essential for human habitation and rice cultivation.

On the other hand, as Brocheux (1995:9), in his study of colonial history in the Vietnamese portion of the delta, notes, "The climate and the natural environment of Mien Tay (the western half of the delta and the portion most directly connected to Angkor Borei) do not present insurmountable obstacles to human settlement. On the contrary, they offer rich agricultural possibilities. The climate and soil are suited to flooded rice culture. But settlement is only possible if the water is controlled." It is also important to appreciate that the impact of flooding from the Mekong is greatly alleviated by the peculiar drainage pattern into the Tonle Sap and, to a lesser extent, the Angkor Borei basin. Consequently, the flat

delta land around Angkor Borei is spared intense flooding and, once drained, can support the cultivation of rice.

Thus, Angkor Borei is located in an environment where human inhabitants are forced to live in their houses and on their boats for four to five months a year; the natural vegetation cover is dense and difficult to control; and drinking water is scarce in the dry season and consequently heavily polluted with sediment and organic matter. Yet, this same environment is also intensely fertile because of the annual deposition of silt laid down by the retreating floods. Although later civilizations moved their capitals away from the delta to more hospitable environs, it is very possible that land use in the delta has remained sustainable over 2000 years.

The ability to maintain soil fertility over time has been a major challenge to Asian civilizations. The Chinese, for example, developed a sustainable agricultural system based on a meticulous scheme for recycling organic waste; agriculture in Japan, the Philippines, and Java was based on rich volcanic ash soils. Good rice crops, for instance, are still grown around Borobodur in central Java, much as when the temple was built in the ninth century A.D. The agricultural fields that supported the twelfth-century temples of Pagan in northern Burma, however, are now barren and support only meager crops of peanuts, and the upland soils of Siem Reap now yield an average of only 800 kg of paddy per hectare (Lando and Solieng 1991).

In Cambodia, farmers never developed the Chinese system for recycling organic waste, and most soils are not naturally fertile; in fact, most soils in Cambodia are frequently cited as being mediocre or poor (e.g., Delvert 1961 : 354). But scholars have failed to recognize that small-scale farmers in Cambodia responded to a unique set of circumstances created by being located in a major river delta within low-lying basins that allow rising floodwaters to spread out across the landscape and to deposit loads of fertile silt. By combining the careful selection of indigenous rice varieties with an ecological understanding of the timing of retreating water, the farmers of Angkor Borei and the lower Mekong basin developed and maintained an extremely productive and sustainable rice-growing system. The high productivity and sustainability of this system, however, are counterbalanced by the significant hardships flood-recession farmers endure to live in this delta environment.

Higham (1989) suggests the Funan civilization grew to importance in the Mekong Delta because the delta is a nodal point for transporting goods between the routes over the Malay-Siamese isthmus and the coast ports of Viet Nam and southern China, and because the delta is a control point for the flow of goods from the rich hinterland that extends across the plains of central Cambodia and into the Korat plateau. But equally important to the growth and success of Funan may have been the fact that the Mekong Delta is actually a very rich and fertile environment for growing rice. Funan grew to importance not only because of its role as a trade center but because it was more than self-sufficient in food.

It is entirely possible that more than 1600 years ago, farmers in Angkor Borei developed a farming system, dry-season flood-recession rice, that became the basis of future civilizations in the lower Mekong basin, including Angkor and the Tonle Sap. Given the high productivity of this system, its proven sustainability, and the role we hypothesize for it in the history of the lower Mekong Delta, any

irrigation project that would disrupt the flood-recession system should be scrutinized carefully. The standard data-collecting procedures for building most irrigation projects may well overlook (as generations of geographers and archaeologists have done) this technologically simple but highly nuanced and sophisticated indigenous water management system.

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NOTES

1. Pierre Paris (1931: 221–224, 1941: 365–372) described five canals that he claims were built somewhere between A.D. 1 and 600. The canal Paris calls “canal 1” is the canal that villagers call “Prek Chik.” We agree that this is probably ancient, and we believe it was built to drain water away from the city. We are not yet prepared to comment on the other four canals described by Paris.
2. One informant told us that 1 *tao* equals 15 kgs (this agrees with Delvert), but rice merchants purchase rice from farmers on the basis of 1 *tao* equals 12 kgs, so farmers lose 3 kgs.
3. According to the Angkor Borei District Agricultural Office, in 1995 farmers planted 7675 ha of flood-recession rice and 3878 ha of wet-season rice. We do not yet know how large an area Angkor Borei district covers or how it overlaps with the 10-km buffer around the city.

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ABSTRACT

The Mekong Delta is famous as the hearth of one of the earliest civilizations in mainland Southeast Asia. Called “Funan” by visiting Chinese dignitaries, the lower Mekong Delta housed at least two urban centers by the third century A.D.: Oc Eo in Viet Nam and Angkor Borei in Cambodia. Land-use practices found in and around Angkor Borei today are described and the relative antiquity of these practices is speculated upon. Dry-season flood-recession rice, the major land use in the area, is an ancient land-use system that, taking advantage of the fertile silt deposited by the annual floods, is both extremely productive and sustainable. Although we have no physical evidence of flood-recession rice in third-century Angkor Borei, there is no technical reason (soil fertility, water, technology, or labor) why it could not have formed the agricultural basis of this civilization. In fact, dry-season flood-recession rice not only may have formed the agricultural basis of Angkor Borei in the early historic period but also may have dictated the location of the city. Furthermore, it is hypothesized that the system of dry-season flood-recession agriculture was adopted elsewhere in the delta either in advance of or in congruence with other lower Mekong polities (e.g., Chenla and Angkor). If this hypothesis proves true, then dry-season flood-recession rice has played a much larger role in the early history and culture of the lower Mekong Delta than has been appreciated by students of the region. **KEYWORDS:** Southeast Asia, Cambodia, Mekong Delta, rice agriculture, flood-recession farming, Geographic Information Systems.