culture began very early in the Preclassic period, judging from the Late Archaic radiocarbon date and projectile point associated with the surface of the basal clay, absence of ceramics in the organic-rich paleosol, and the radiocarbon dates from Albion Island. Farmers at this early date apparently took advantage of natural hummocks in the swamps, some of which may have been remnant gilgal formed centuries or millennia earlier.

At Douglas Swamp, as on Albion Island, a rise in water levels occurred after the initial phase of wetland agriculture, but prior to the first evidence of canal construction. Therefore, canal construction may well have been a response to rising water levels as we and others have hypothesized (Bloom et al. 1985; Pohl et al. 1990). Water levels continued to rise, and many of the wetland fields appear to have been abandoned before the Classic period.

An episode of colluviation of the swamp depressions followed canal construction, perhaps caused by settlement expansion and human-induced hillslope erosion that may have begun in the Preclassic, but peaked in the Late to Terminal Classic. The combination of rising water levels and colluviation eventually permanently submerged the wetland fields, silted in the canals, and led to the precipitation of pedogenic carbonate and gypsum over the eroded fields. The precipitates did not accumulate in the sediments overlying the canals or small depressions separating hummocks because these low areas remained too wet for precipitation to occur. This process resulted in the natural raising of the surface over the fields even though the agricultural surfaces were buried by over a meter of sediment.

This raised appearance, and the accumulation of pedogenic carbonate and gypsum over the fields and not the canals, led previous researchers at Pulltrouser and Douglas swamps to interpret the raising as human constructions. We cannot totally discount the possibility that these raised surfaces were cultivated, perhaps in the Terminal or Postclassic periods. Nevertheless, the patterns of fields found throughout northern Belize appear to be the result of a much earlier, Preclassic episode of wetland agriculture as well as the result of natural deposition on an ancient hummocky terrain.

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II

Settlement and Land Use in the Pulltrouser Swamp Archaeological Zone, Northern Belize

Peter D. Harrison

Pulltrouser Swamp lies near the east coast of the Yucatán Peninsula, in the north of the modern country of Belize in Orange Walk District. The swamp consists of three interconnected arms, each roughly oriented north-south and parallel to the New River, which in turn flows northward to drain into Chetumal Bay near the major site of Caracol. The three arms are identified as Pulltrouser West, Pulltrouser East, and Pulltrouser South. The west arm dries completely periodically, not necessarily every dry season, according to the ambient local water levels each year. Water levels in the eastern and southern arms fluctuate with the seasons, but have not been known to dry completely in recent times. The south tip of Pulltrouser South is in such proximity with the sources of the New River that a connection is assumed. In fact, two probable canals making such a connection are visible from the air. These canals were undoubtedly utilized and perhaps enhanced by the logging industry that flourished here in the nineteenth century, but an ancient Maya origin also remains a good possibility.

Interest in the swamp complex was stimulated by recognition of ground patterns along the edges of Pulltrouser East and South, which were visible from the air and interpreted as indicative of the presence of raised fields. At least two ancient settlements had been reported near the swamp border by Norman Hammond (personal communication, 1979).

Excavations took place over two field seasons in 1979 and 1981, each of which was funded by the National Science Foundation. Direction of the project was shared between me, in charge of the settlement studies, and B. L. Turner II, in charge of ecological studies within the swamp and along its borders.

Much of the data from the first season of investigations in 1979 at Pulltrouser Swamp have already been reported (B. L. Turner and Harrison, eds. 1983). However, only a small part of the data from the major season in 1981 has

THE 1981 FIELD SEASON

In 1979, ground proof for intensive agriculture was sought and recovered to the satisfaction of the project directors. In 1981, a more comprehensive study was launched with the goals of completing the settlement survey and amplifying the study of the raised fields and the ecological history of the study zone. This paper concerns only the settlement portion of the study and its relevance to the overall aims, which were to compile the recorded settlement size and its projected populations with the potential for food production within the swamp basin.

The 1981 field season in Pulltrouser Swamp undertook to survey the whole of the borders of the archaeological zone surrounding the three arms of the swamp. At first, it was planned only to survey a sample of the zone, assuming that a full mapping project would be beyond the means of our funded budget. However, as the season progressed, the need for recording everything became the rule rather than the exception. As a result, the survey of the settlement accomplished an estimated 90 percent record of settlement features in the study zone. Generally, this included the entire dry area between Pulltrouser East and West and a zone ranging between 700 m to 1 km from the east and west extremities of the swamp borders. There remain a few areas around the northern boundaries of the east arm of the swamp complex where the survey was not as complete as elsewhere due to factors of field time as well as difficulty of access. A set of twelve detailed maps—which of settlement clusters and one of the overall study zone—has been completed and awaits publication with the report of the 1981 season.1

The survey produced evidence of ten communities that had settled about the three arms of the swamp over a long period of time. The main characterization of the swamp settlement is that it was nucleated and discontinuous, both spatially and temporally. These observations, resulting from nine months of intensive excavation, are relevant to the interpretation of the uses of the swamp borders.

CHRONOLOGICAL CHANGES IN SETTLEMENT AT PULLTROUSER SWAMP

Middle Preclassic: The Earliest Occupation

The earliest occupation found dates to the Middle Preclassic. Recently, some controversy has appeared in the literature about the dating of such early

1. Approximately thirty sets of these maps have been distributed to interested colleagues, and one set is on file with the National Science Foundation.

scats at sites in northern Belize, such as Cuello, as well as at Pulltrouser Swamp (E. W. Andrews 1990; E. W. Andrews and Hammond 1990). The net result of these discussions has shown a consensus that the earliest regional occupation seems to date to around 1200 B.C., which fits the revised readings of 14C dates from various locales in northern Belize, including Pulltrouser Swamp.

The ceramics from the Pulltrouser zone correlate well with the earliest from Cuello, as well as with those from Colha. It would seem that there were general small settlements throughout northern Belize represented by the Swasey/Bladen ceramic complex, if not earlier. These people, however, showed no sign of having used the swamp for any purpose other than water transportation and other means of life support. Three separate sites yielded Middle Preclassic ceramics: (i) K’asob on the east; (ii) Pech Titon on the west boundary of Pulltrouser South; and (iii) Group A of Tzibal, just north of the same arm of the swamp (Figure 11.1).
Settlement and Land Use in Pulltrouser Swamp

The Early Classic period at Pulltrouser is characterized by the settlement data by the stability and growth that are typical throughout the Maya Lowlands. During this period there occurs a house pattern of dual houses in a group, as opposed to the more usual three- or four-sided plazuela. This configuration was reported by William Haviland (1965) at Tikal during the Early Classic period, and it is interesting to find it again in this relatively rural setting. Evidence for use of the fields in this period is scanty, and does not correlate with the growth indicated by settlement (Figure 11.3).

Late Classic

The Late Classic period exhibits, here as elsewhere, the same explosion of occupation that has come to be expected in all parts of the Maya Lowlands. There is yet to be found a site that will adequately disappoint in this regard, and

Late Preclassic: Earliest Intensive Use of the Swamp

Expansion of population in the Late Preclassic was dramatic, but not unusual for the Maya Lowlands in general. No special significance could be attributed to this expansion when compared to the general pattern already known from excavations throughout the Petén and Belize.

The first correlation of settlement with use of the swamp for intensive agriculture is suggested at this time by the presence of Late Preclassic-period ceram-
the Pulltrouser zone is no exception. If the quantity of ceramics found, in conjunction with the quantity of structures raised in communities around the swamp border, can be trusted as an indicator of the population level, then the Late Classic period is, as elsewhere, the highest period of occupation (Figure 11.4). This highest level of population is evident in all ten settlements in the archaeological zone, and corresponds to the date of artifact materials from the raised fields. The conclusion can only be that many, if not most, of the fields date to this period in construction as well as use.

Interpretation of the use and date of the fields rests on the assumption that direct association of artifacts with construction is an indication of function as well as date. Of course, there are well-known caveats for this assumption, but the correlation here is surely testimony that the major use of the fields and of the swamp complex itself as a source of agricultural production dates to the Late Classic period. The conclusion is that the raised fields of Pulltrouser Swamp were used primarily, but not initially, during the Late Classic period. The growth of the settlement bears out this assumption. Preclassic settlement is restricted to a few locales, around the larger centers of K'axob and Kokeal, and near the smaller, early settlements of Tibaat, Group A, and Chi’al. Each of these early settlements expanded greatly in the Late Classic period, and the extent of the raised fields apparently expanded with this growth. More convincing, however, is the fact that most of the scattered settlement of the site of Tibaat dates to Classic period construction and is directly associated with large numbers of raised fields in Pulltrouser East. The majority of this growth in the Classic period is Late Classic in conformity with the date of recovered ceramics from
the associated raised fields. This correlation between two parts of the study zone that are predominantly of Late Classic construction—settlements and raised fields—is a strong argument that the fields themselves were a primary focus of the Late Classic period. Our reconstructions for population versus food production, which show a production far beyond the needs of the local population are from the Late Classic period (B. L. Turner and Harrison, eds. 1985).

Terminal Classic

The Terminal Classic period is surprising for the strength of its endurance and continuity from the preceding period. The surprise is that so much occupation continued into the Terminal Classic period. This period has been described only recently, and still inadequately. As a result of the David Pendergast and Elizabeth Graham excavations at Lamanai (Pendergast 1985) and Txicul (cited in G. D. Jones 1989) in Belize, it is now known that occupation by the Maya in northern Belize was continuous at many sites, extending into the Contact period at least at some sites. This record is in contrast to the collapse and near total abandonment that had occurred in the Petén and elsewhere. Perhaps it is this survival of populations beyond the Late Classic period that was in operation in the Fulltrouser zone. Indications are that intensive exploitation of the swamp and its fields continued into the Terminal Classic period, but at Fulltrouser this was not a major period of use.

Early Postclassic

Finally, the ceramic record indicates that use of the swamp borders did continue into the Early Postclassic. However, this presence was quite minimal—a residual, passing occupation that seems to have been incidental rather than a significant factor of the chronology of the swamp zone.

SIGNIFICANCE OF THE COMMUNITIES IN REGIONAL CONTEXT

The communities of occupation that compose the Fulltrouser Swamp zone can be viewed as part of a larger regional matrix. This argument has been published elsewhere (Harrison 1989, 1990) and will not be reiterated here, except to point out that the pattern of local site spacing shows that only K'axob participated in the regional matrix of high-ground sites, ranging from the regionally dominant Nohmul in the north to Cuello in the south, with its Middle Preclassic associations (Figure 11.5).

Those sites which have the greatest longevity of occupation are Kokteal and K'axob. The chronology of each extends from the Middle Preclassic to Early Postclassic, but with varying degrees of continuity. Only K'axob has a continuous occupation for the entire sequence at Fulltrouser Swamp. K'axob is also the only site that exhibits the rare Postclassic occupation. Having these unusual characteristics, it must be one of the significant sites in the development of northern Belize.

A NEW TYPE OF RAISED FIELD

K'axob is also unusual in its association with the third type of raised field to be found around the boundaries of Fulltrouser Swamp. This field type is a variant form of the two previously defined by B. L. Turner (1985a). It is a com-
bination of the channelized and raised field types (Figure 11.6), with a shallow layer of solum overlying a thick layer of sascab in only part of the formation; whereas the rest is constructed of artificially moved materials as in the B. L. Turner and Harrison definition of a raised field (eds. 1983), and was raised a full meter higher than its counterparts facing the same body of water, namely Pulltrouser South. While fields on the west side of this arm of the swamp were raised to a height of approximately 1 m adjacent to the site of Tibaat (for example, R.F. 9), those on the east side, adjacent to K'axob, were raised two meters above the same body of water (for example, R.F. 7) (Figure 11.7). This evidence eliminates the possibility that such strata, interpreted by the Pulltrouser project as artificial, could have been the result of any natural cause such as high-water deposition. Water does not deposit soils with a differential of one meter on alternate sides of a single body of water.

OTHER ANTHROPOGENIC FEATURES IN THE SWAMP

Two further items of evidence are of interest concerning the production and use of the fields at K'axob. The following two features, observed during a visit to the McCannary excavations in 1992, were found along the eastern edge of Pulltrouser South, both near the northern boundary of the swamp fields in this arm of the swamp complex.

The first appears to be a secondary construction beside a raised field that was totally detached from the east shore of the swamp, where the shore is approximately 1 m above the water line, at least in June of 1992 (Figure 11.8). Here were constructed a pair of low walls connecting the southern and northern ends of the field to the shoreline. The northern wall has a gap or gara, leaving the enclosed space open to the canal waters to the north. Such an enclosure is surely a fish-holding tank of the kind described by J. Eric S. Thompson (1974) and by Dennis Puleston (1977). The opening could be easily controlled by a weir of perishable materials very like one that still exists elsewhere in Pulltrouser South (Harrison 1993). This construction is evidence of the secondary use of the canals as a source for raising, catching, and holding fish in ancient times.

The other construction is a berm at the very northeastern corner of Pull-
trouser South (Figure 11.9), where the pattern of raised fields comes to an end and the final, northernmost canal follows the north edge of the modified swamp. Here, we find that the excavation of the canal has resulted in the piling up of swamp soil not only on the adjacent raised field which forms the south side of this canal but also up onto the shore to the north where no other fields occur. In the absence of excavation and recovery of period ceramics, one must consider the possibility that these two features are the result of the nineteenth-century logging operation. However, neither construction is in a location that would be logical for the movement of logs through the swamp toward the connection at the south end. I view these two phenomena as further evidence of both the use of the swamp (fish tank) and the method of constructing fields and canals (the berm).

CONCLUSIONS

Since the original version of this paper was presented in August of 1991, a small group of investigators has ventured to reexamine several sites in northern Belize where raised fields were reported as part of the cultural kit (see chapters in this volume by Pohl and Bloom and by Pope et al.). This group has even ventured to reopen the excavations at several of these sites. In conformity with their stated theoretical position made at the time funds were sought, this group interprets the situation in northern Belize quite differently from the mainstream of archaeological interpretation. Their claim is that intensive agriculture occurred only during the Late Preclassic period and that the culturally laden constructions which archaeologists have interpreted as man-made (anthropogenic) are, in fact, natural formations. This is an old argument that predates the investigations of the late 1970s and early 1980s, at which time such a stance was disproved to the satisfaction of the community of professionals at large. However, since the "evidence" found by this group has been presented only orally at professional meetings, we await the written word on their results before attempting to answer their claims. I have written extensively on the reasons why archaeologists and others view these constructs (raised fields) not only as man-made but also as dating to the Late Classic period for the most part. For the curious, I refer to my

2 The group is headed by anthropologist/archeologist Dr. Mary Pohl and soil scientist Dr. Kevin Pope. The project has been generously funded by the National Science Foundation for three years of field study.
III

Problems in Agricultural Sustainability: Mismanaging the Mosaic?