RECREATIONAL URBANIZATION AND SHORELINE MODIFICATION
ALONG THE NORTH COAST OF YUCATÁN, MEXICO

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Introduction

The north coast of Yucatán has been a beach destination for domestic tourists from Mérida, the state capital, since the 1880s. As a 20-km stretch of coast evolved into a contiguous urban zone of beachfront summer homes during the 1950s and 1960s, shoreline erosion became an increasing problem, especially west of Progreso where extensive port and harbor construction had taken place. Property owners responded by constructing groins, which accelerated the problem of downdrift erosion and, in turn, stimulated ever more groin construction. By late 1980s, the shoreline west of Progreso became very degraded as a result of human-induced erosion and futile efforts at combating it. During the 1990s the locus of groin-building shifted to the east where the coast historically had been fairly pristine. Most of the groin construction was (and is) attributed to misguided efforts by second-home owners to stabilize a shoreline that naturally fluctuates in position.

This research is presented as a case study in recreational urbanization and physical impacts along the north coast of Yucatán. By analysis of a study area east of Progreso, it is demonstrated that recreational urbanization stimulated by domestic tourism has become as much of a contributing factor in shoreline modification as port and harbor improvements were in the past. The beaches that attracted domestic tourists are now in danger of being destroyed by them, and regulatory agencies have so far had little impact in slowing the process.

The Physical Setting

The north Yucatán coast consists of a beach-ridge plain accreted onto the limestone platform of the Yucatán peninsula where it dips gently northward into the Gulf of Mexico (Meyer-Arendt 1993). This ‘barrier’ is separated from the rocky mainland by a lagoon system generally referred to as la ciénaga (lagoon/wetlands), but known as the Estero Yucalpetén near Progreso. Active dunes up to 3 m high occur in unmodified zones of the beachfront. The shoreline is smooth and straight, except where interrupted by small Pleistocene limestone outliers, some of which function as natural breakwaters and locally reduce wave energy (Sapper 1945; Edwards 1954).

Wave energy is relatively low along the north coast of Yucatán, except during storm events. Because of its orientation, the north coast is exposed to onslaught by wintertime nortes (northerns) more than by hurricanes. On the average, 20-25 nortes reach Yucatán annually (Vivó 1964; Mosiño and García 1974), and the strongest cause erosion and lagoonal flooding. Hurricanes pass over or near the Yucatán peninsula usually once a year (Wilson 1980), but only rarely are they of
the magnitude of Hurricane Gilbert of 1988 (Meyer-Arendt 1991a; 1991b). Sometimes hurricanes in the northern Gulf of Mexico raise water levels and initiate a reversal of longshore currents. This reversal, driven by the rare west wind called chikin-ik by the Maya, may cause erosion along localized reaches that normally lie in sheltered lee locations (Meyer-Arendt 1993).

Analysis of aerial photography revealed variability in shoreline changes along the north coast of Yucatán since the 1940s. Although the scale of the photographs precluded accurate measurement, the high rates of change were measured west of Progreso. Immediately west of Progreso wharf, rates of 0.3 to 0.6 m/yr were measured for the 1948-1978 period, and downdrift of the jettied Yucalpetén harbor entrance rates approached 1.0 m/yr (Meyer-Arendt 1987b). By contrast, the coastal zone east of Chichxulub Puerto remained relatively stable until the 1990s. But in spite of this apparent stability, phases of accretion alternated with phases of erosion were evident in intermediate sets of photos.

**Shoreline Modification**

Modification of the north Yucatán coast via construction of shoreline structures dates back to the initial platting of Progreso as a port city (Meyer-Arendt 1993). Ever since the first wharves were constructed in Progreso in the late nineteenth century, the western (downdrift) zone has experienced the highest local rates of erosion. Although Dutch engineers designed a new (in 1947) 2-km-long wharf to allow throughflow of water and sediments (Campos 1990), high rates of downdrift erosion were soon noted. As a consequence, the earliest beachfront touristic development was to the east, along what became the Progreso malecón (promenade) and eastward to Chichxulub Puerto.

Groins became widespread along the north coast in the 1960s, perhaps because they were perceived as an effective means of trapping longshore sands and combating erosion. The first rock-and-timber groins (espolones), locally known as ‘spurs’ (espolones), were constructed at Chelem and Chichxulub Puerto in the late 1950s (Sánchez and Vera 1963). Because of poor design, however, the espolones were not very effective and accelerated downdrift erosion. In 1964, government engineers designed and installed a groin field along the Progreso malecón to maintain a wide beach for day-use recreationists (Meyer-Arendt 1987a). Because of the success of this engineered groin field, groin construction became ever more popular among Yucatecan summer-home owners.

In 1968, a safe harbor (puerto de abrigo) for the Progreso fishing fleet, a naval station, and industrial development was created and the port of Yucalpetén established. A navigation channel was excavated through the beach-ridge plain, and jetties (escolleras) built to keep the channel open. Downdrift of the jetties, the shoreline began to retreat rapidly—as much as 30 m in the first few years, and widespread construction of espolones began.

Unlike the Progreso groins, the ones extending westward from Yucalpetén were neither authorized nor professionally engineered. Although construction permits were legally required from the Secretaria de Desarrollo Urbano y Ecología (SEDUE), the federal regulatory agency, property owners built groins on a piecemeal basis without obtaining permits (knowing fully well that SEDUA had no enforcement powers). The village council (comisario ejidal) of Chelem did not object to the shoreline armoring, nor did any regional, state, or federal authorities, even though the groins were within the 20-m-wide beach easement known as the Zona Federal Maritimo Terrestre, or Federal Coastal Zone (Merino 1987). Continued groin construction gradually shifted the locus of erosion westward, and, in response, the corollary leading edge of espolón construction. By the mid-1980s, the cause-and-effect relationship between groins and erosion was recognized, and Chuburná Puerto (the community west of Chelem) officials removed several espolones and began to enforce the existing local ban on unauthorized.

Whereas the groins west of Yucalpetén were built in response to erosion created by port improvements, east of Progreso the causal relationships were not so clear. In Chichxulub Puerto, a short wharf (now derelict and partially removed) may have contributed to shoreline erosion and corollary groin construction in the late 1950s and early 1960s. East of Chichxulub Puerto, however, there was no port or industrial construction nor were there any groins until the area began to fill in with vacation homes and condominiums. The first groin was built in the early 1990s, and by late 1999 a 5-km-long stretch had become armored with approximately 100 espolones, causing the coastal landscape to resemble the erosional, debris-strewn beachfront of Chelem.

**The Recreational Urban Frontier: A Case Study in Coastal Impacts**

The coast east of Chichxulub Puerto has remained relatively pristine until recently. By the late 1990s, however, the landscape had evolved into a Chelem-style shoreline landscape of groins and seawalls, and the “recreational frontier” of vacation-home development had shifted eastward toward Uaymitún. The 5-km-long coastal reach immediately east of Chichxulub Puerto provides an excellent case study to better understand the processes of recreational urbanization and corollary shoreline modification within the entire recreationally developed north coast of Yucatán.

In the 1940s, development was just beginning to extend the village of Chichxulub Puerto eastward along the shorefront, but except for a few coconut plantations, the scrubby beach-ridge plain was empty. In the nearshore at the Cocal San Miguel lay a cluster of Pleistocene-age limestone rocks which sheltered a sandy headland along an otherwise smooth and straight beach and perhaps influenced the original establishment of a plantation at this site.

In terms of historic shoreline changes, alternating phases of shoreline erosion and accretion were documented for this reach of the coast. Existing aerial photography revealed that the shoreline position has been highly variable since 1948, especially immediately west of the San Miguel headland. Whether this is attributed to “pulses” of longshore-driven sediments or the onshore-offshore
transport of beach sediments is not clearly understood. The latter is a frequent natural process that varies seasonally as a function of the amount and intensity of storms and barometric pressure and corollary sea levels, which are enhanced periodically by tropical cyclonic activity. Also not clearly understood is the sediment-storage function of the headlands. Some years the San Miguel beaches appeared to be wider, while at the same time the downdrift beaches appeared narrower. Although the resolution of the photographs precluded making definitive conclusions about underlying processes, the alternating phases of erosion and accretion appear to be typical in this area.

As recreational development took place in the 1960s, 1970s, and 1980s, the actual siting of the beachfront vacation homes played a great role in the perception of erosion and subsequent attitudes toward groin construction. A greater distance from the shoreline and further behind the foredunes ensured lowered risk from wave erosion threatening the foundations of homes. Many local summer homes were built inland of the second line of dunes, and to date they have not been threatened by erosion. However, many vacation homes were built on or just behind the primary dune, as in the Diana Milán subdivision.

The mid-to-late 1980s was a period of much storm activity in the Gulf of Mexico, and the combination of shoreline erosion and hurricanes was followed by groin construction in those areas where threats to house foundations were perceived. The 1985 hurricane season initiated a phase of erosion in the Chicxulub Puerto/San Miguel area, although Hurricane Gilbert, which in 1988 destroyed almost every beachfront structure along Yucatán's north coast, surprisingly left a wider beach along most of the coast (Meyer-Arendt 1991b; 1993). Within a few years, however, the shoreline again began to encroach. Based partly upon advice requested by and provided to summer-home owners by port employees moonlighting as erosion consultants (even calling themselves 'engineers'), the first groins east of Chicxulub Puerto were built in the early 1990s. Some homeowners attributed the increased erosion in this area upon the 5-km-long rubble-mound Progreso wharf extension, although no data to support such a claim exist.

An inventory of groins conducted in 1994 revealed 1) intensive new groin development west of the Chicxulub Puerto wharf, 2) a scattering of groins between Chicxulub Puerto and Diana Milán, and 3) a recently completed groin field at the Diana Milán subdivision. There, an indentation in the shoreline had left homes perching precariously just above the surf zone in 1994, and homeowners had turned to groins as a “last resort” to save their property. Some claimed that an updrift homeowner had earlier constructed a 50-m-long groin to extend the beach in front of his home, and this had caused the erosion at Diana Milán, although no data to support such a claim were found.

By late 1994, there were 12 groins at Diana Milán, and their ineffectiveness was evident. The three updrift groins exhibited partial success in trapping sand, but along the other nine, erosion had increased and waves were lapping at the houses' foundations. Homeowners near the western end of the subdivision soon felt the pressure to construct their own groins, if only in the anticipation of trapping sand and protecting their homes and salvaging their beach. A few resisted the pressure to build, but most gradually accepted groins as necessary evils. Again, private homeowners did not petition for permission from the SEDUE but rather contracted with unofficial “coastal engineers” to design and construct their groins. By 1995, more groins had been built west of Diana Milán—a trend of downdrift groin construction very reminiscent of the pattern at Yucalpetén and Chelem in the 1970s.

By Fall 1999, groin construction had been extended from Diana Milán to the Chixculub Puerto wharf. During a beach survey in August, approximately 100 groins were counted, 80 percent of them constructed since 1994. Although the shoreline position did not appear to have changed significantly since 1994, local homeowners described short-term phases of erosion and accretion in interviews with the author.

Although the natural phases of shoreline erosion apparently accelerated the construction of groins, there was little evidence that the groins stimulated much beach accretion. One exception was at Diana Milán, where most of the groin field was now completely covered by a nice wide beach. This may have been the result of a natural “pulse” of sand moving in from the east. More typically, most of the coastal landscape had become very “scalloped” and degraded because of the many groins.

Not only were both flanks of Progreso beginning to resemble each other in late 1999, but the pattern of shoreline armoring was beginning to diffuse eastward as well. At Tropical Riviera, a subdivision east of San Miguel containing vacation homes and condominiums, 15 groins were built in late 1998 and early 1999. The impact of this recent development upon the San Miguel headland and the downdrift beachfront of Diana Milán is yet to be determined, but if other modified coastal reaches offer any clues, the prognosis is not good.

Conclusions

Along the north coast of Yucatán, both older urban development and newer recreational development must share blame for encroaching too closely upon the primary dunes and shorefront to allow natural fluctuations in shoreline position. Where the shorefront historically has been altered by port and harbor improvements, downdrift erosion has been accompanied by groin construction that has only accelerated the problem of beach erosion. The Yucalpetén and Chelem shorefronts still exhibit a post-Hurricane Gilbert landscape of concrete rubble instead of a sand beach. The ineffective groins only add to the surreal and depressing coastal landscape.

East of Chixculub Puerto recreational urbanization alone is responsible for the recent degradation of the beaches. Poor siting of vacation houses, an inability (or unwillingness) to adapt to a dynamic shoreline, and a propensity to turn to groin construction are all to blame for the aesthetic deterioration of the
beachfront. Historic photos have shown that the north Yucatán shoreline is fairly stable and that phases of erosion and accretion are normal. The construction of over 100 groins since 1990 has not improved the coastal environment but rather accelerated the degradation of this coast similar to coastal reaches to the west. Although construction of groins without permits is illegal in Yucatán, summer-home owners represent the political and professional elite of the state, and it is unlikely that groins will be banished.

Seasonal local tourism is responsible for the spreading of ineffectual erosion-control techniques into pristine coastal landscapes, and it is apparent that certain minimal coastal-zone management techniques—such as zoning and construction setbacks—need to be implemented to prevent the entire north coast of Yucatán from resembling Chelém. International tourism has recently begun in Yucatán (in the form of an all-inclusive resort near Telschac Puerto, to the east of this study area), and local civic boosters would like to attract cruise-ships and more Cancún-style development. But if poor planning and shoreline armoring continue to diffuse eastward, the shift from domestic to international tourism will be shortlived. Unfortunately, with the exception of the establishment of wildlife preserves (especially in the pink flamingo nesting sites), there is no comprehensive management plan to guide touristic development and beach preservation. Coastal management should be the responsibility of the State of Yucatán, which stands to benefit from properly designed development of its coastal resources. And while it may be too late to improve the aesthetic appearance of the 20-km coastal stretch centered upon Progreso, it is within this zone that coastal managers need to look to understand the processes of beach degradation associated with urbanization, port improvements, hurricanes, and tourism development. Hopefully, lessons learned can be applied to the remainder of Yucatán’s beautiful beaches.

References


Acknowledgments

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