BEACH MANAGEMENT EXPERIENCE AT PARADISE ISLAND

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INTRODUCTION

The authors of this presentation made at the Coastal Zone Management Workshop, BEST Commission, on 29 November, 2000, have had the privilege of consulting on small- and large-scale coastal developments throughout the world. As a consulting engineer practicing specifically in the field of coastal management and restoration, the first author's principal practice is in the southeastern U.S., the Caribbean and Hawaii, and has included the design of about 30+ beach restoration projects, large-scale reef restoration projects, and numerous resort developments. Of these projects, personal favorites have included a great many assignments throughout all of the Family Islands of the Bahamas and around New Providence, including substantial works for Kerzner International Development Ltd. at Atlantis and Ocean Club, Paradise Island.

The key to the success of these projects, and to coastal zone management in general, is to establish in the stakeholders a grasp of the fundamental precepts of coastal engineering and management. Foremost, it is essential to understand that proper attention, funding, and precedence be given to beach and coastal preservation because these shores are critical to:

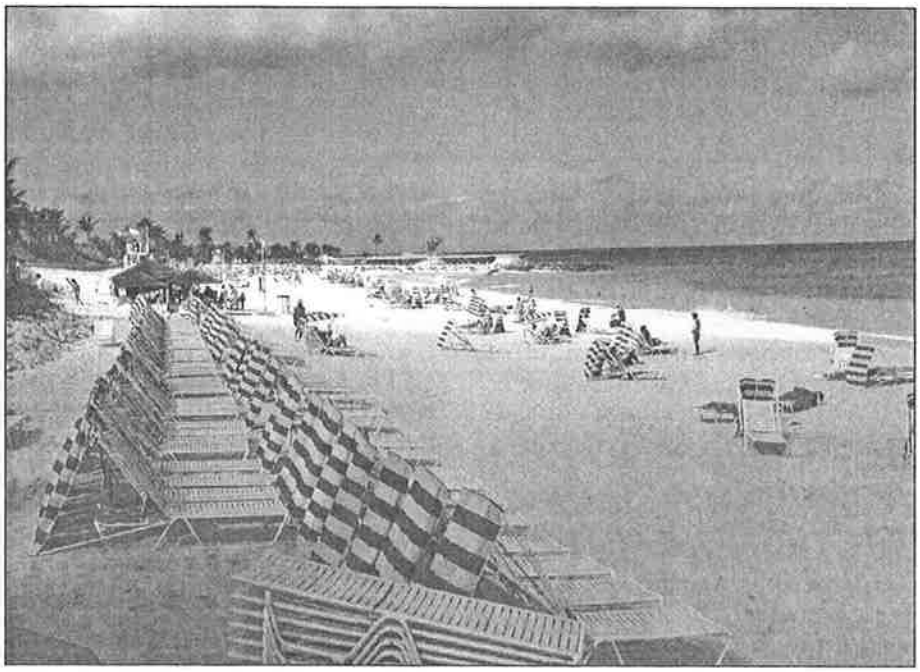


Figure 1. Atlantis Beach a few days after Hurricane Michelle. (Photo: Sealey)

- tourism and its economic impact to the Bahamas, and
- the cultural heritage and the quality of life of the Bahamian people.

If you do not proactively restore and protect your beaches, they will be gone. Further, in this tourist-based economy, the beach and waters are the economic engine that drives the train. And like any engine, it has to be maintained. But, here, the beauty is that this engine is akin to a perpetual machine. The financial resources you put into the beaches are returned many times over -- allowing ever-expanding improvements to benefit the nation.

The State of Florida recognized this fact over the last decade. Florida now has a dedicated fund of $30M per year for beach management and restoration. These funds accrue from a portion of proceeds raised by stamp (document) taxes on real estate transactions. Matched

Figure 2.
Before and after restoration of Pirates Cove shoreline by removal of former seawalls and structures.

with federal and local dollars, this amounts to over $100M per year for proactive beach management and restoration. This occurred because the State Legislature recognized by Statute that beach management was overtly in the public interest.

RE-ACTIVE AND PRO-ACTIVE BEACH PROTECTION MEASURES

How do you restore and protect your beaches? The alternatives are well-known:

- Retreat
- Relocation
- Shoreline armoring
- Beach nourishment, and where warranted,
- Beach nourishment with stabilizing structures

No one of these alternatives is right everywhere. Particularly on island coastlines, every location will have a different solution. Note that these are reactive measures: responding to erosion that has developed from earlier development.

There are also proactive measures. Proactive measures reduce the potential for erosion problems to develop in the near- and far-future. These proactive measures include the following:

a.) Prudent set-backs and siting of coastal development. Prudent set-backs are not necessarily by some fixed distance from the Mean High Water Line (MHWL). The extent to which any given location on the shore is prone to both acute and chronic erosion is different from place to place. This calls for site-specific setbacks that respect these local differences. We call this physically-based, dynamic set-backs.

b.) Building foundations should reflect the potential for the site to be impacted by chronic and acute erosion. Pile-foundations should be required in storm-erosion susceptible areas (instead of slab-on-grade and simple footer foundations), so that the building does not interfere with the movement of sand and water, and is less endangered by erosion. That reduces the often "knee-jerk" reaction to build seawalls to protect building foundations after a storm – such as occurred along many of the Family Islands after Hurricane Floyd. While piled-foundations are not traditional in the Bahamas, bear in mind that neither is the types and locations of new development being conducted in the traditional Bahamian fashion. People are building in places and in architectural/engineering styles that are no longer traditionally Bahamian.

These reactive and proactive beach management tools are well-known. Coastal engineers know how to design them, and we mostly know what works and what doesn't work. We also know that, on island coastlines, what applies to one location does not precisely apply to another (at least without site-appropriate adjustment).

In this way, nationwide generic studies of coastal conditions are of limited value. Such studies re-state the obvious. Similarly, one also don't necessarily need high-tech, outlandishly expensive studies of a site's waves and currents and geology in order to design a protection plan. A little prudent desktop study, and sound experience, can often go much further than elaborate reports and studies.

FUNDAMENTAL PRECEPTS OF COASTAL PROCESSES

Any reasonable scheme for coastal protection and development must pass certain fundamental precepts of how a beach and coastal defense system works. Many of these precepts are quite simple. For example:

1. A beach is a balance of two forces: waves pushing up, gravity pulling down. Without waves a beach is flat. Failure to recognize this, such as at interior waterways and canals commonly found in residential developments, means a failed beach. That is, a beach requires a "lot of horizontal space" to be stable. Attempting to "force" a beach to exist

in too narrow of a space will result in a failed beach because the sand will simply 'slump' to its natural, gently-sloped profile – ultimately meaning that most of the sand is below the water and little or none is above the water.

2. Structures of themselves, such as groins, don't create sand. Their prudent use can maintain sand that is placed, but cannot provide sand on a sediment-starved coast. Prudent use of structures requires careful design and importation ("advance nourishment") of sand from a source external to the beach system.

3. If you build out on the beach, the beach does not follow you out. At least without special structures, the beach and shoreline is where Nature planned it, and if you push development onto it, the sandy beach disappears. As a classic example, a seawall placed near the natural high water line will not result in the beach re-forming in front of it; it will instead result in a wall in the middle of the natural beach, typically with less (or maybe no) sand in front of it.

4. When waves strike a structure on a regular basis, like at a seawall or revetment, the reflection will erode the beach in front of it, and move the sand offshore onto the reef flat. Here is a simply illustration of the adverse effect of a seawall on the shoreline along a Bahamian beach, which is composed of typically porous aragonite sand: After a storm, waves and sand rush upon the beach, and where the beach is dry (such as along a natural shore), the sand settles out and the water flows downward through the beach, thus building up (restoring) the beach. When the beach sand is low and saturated with water, such as in front of a seawall, the waves and sand rush upon the beach, but the water cannot percolate down through the sand, and so the wave washes back to the sea – carrying with it the sand – so that the beach is not built up or restored.

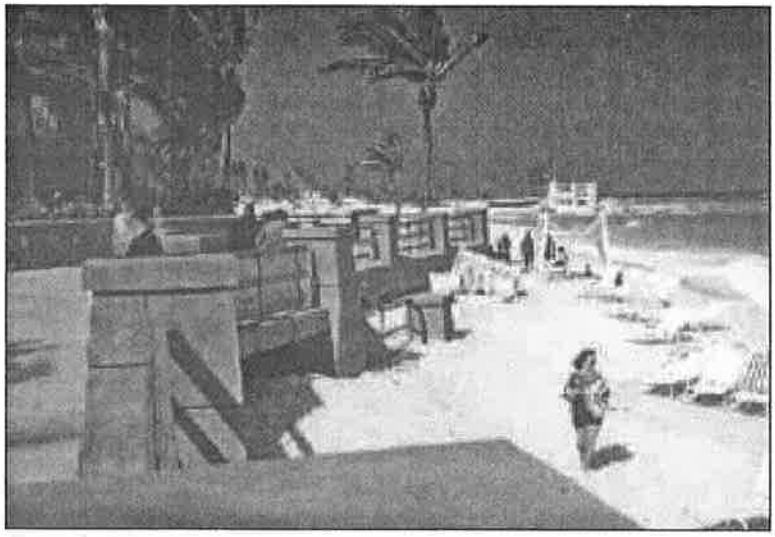


Figure 3. Landward relocation of Atlantis infrastructure away from the active beach, after Hurricane Floyd.

5. Offshore man-made structures that do not break the water surface, like submerged breakwaters, typically have negligible effect upon the waves and beach stability. These structures can actually cause beach erosion instead of halting it. Natural submerged structures – like coral reefs – are much broader in size than man-made structures, and can therefore influence (decrease) wave energy in their lee. Creating man-made submerged structures on this scale is typically cost-prohibitive.

6. If you dig a hole in the seabed, particularly near the beach (for swimming), it will fill back up with whatever it can get -- including the sand on that beach, not to mention cobble, seagrass blades, detritus, etc.

7. Dune fencing and vegetation can help maintain a beach, but cannot restore a beach where there is no sand. Restoring dunes, including planting with proper vegetation, is critical after a storm, but it cannot replace a beach on a shoreline that is sand-starved; i.e., where there is little or no sand in the local shoreline system.

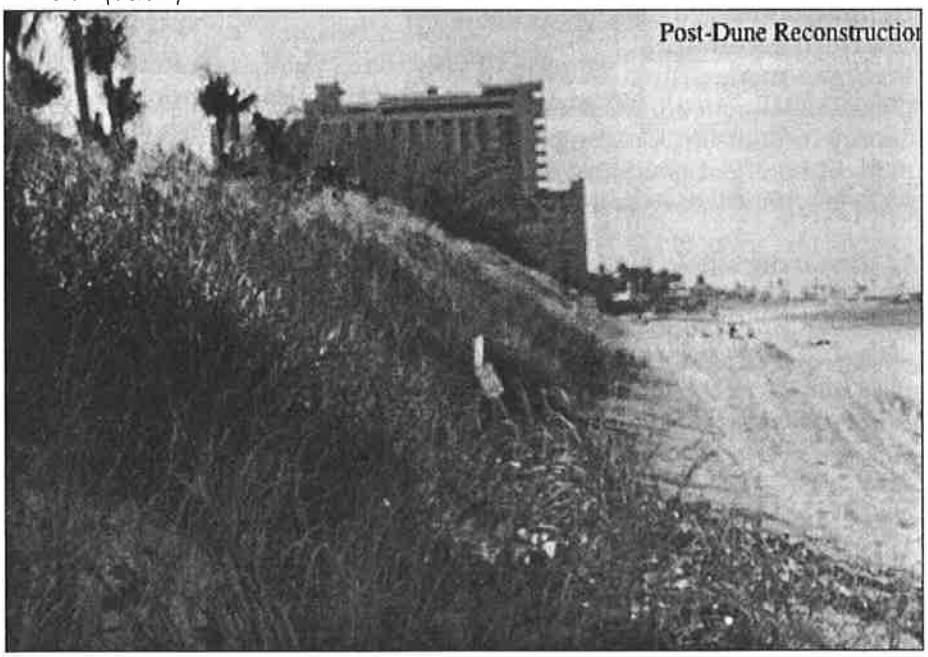
8. Large boulders found high along the backshore mean that large storm waves put them there; and it is probably not a good place to build your house or hotel or restaurant, etc.

9. There are no magic solutions -- not fishnets, nor artificial seagrass, not special shaped concrete blocks, not beach de-watering, nor others. So-called "alternative technologies" have never been soundly demonstrated to have reversed beach erosion. Such systems that claim to reverse beach erosion generally (1) rob sand from elsewhere on the shoreline, (2) improve the beach only in moderate seas, and cannot prevent erosion in storm seas, or (3) result in unaesthetic 'littering' of the beach.

10. Removal of sand from the beach ("littoral") system leads to long-term beach erosion. This removal includes not only mining of sand for construction, but, more subtly, maintenance-dredging of channels and inlets wherein the dredged sand is taken to the upland or dumped in deep water, offshore. As an example, it is widely acknowledged that over 75% of the beach erosion along Florida's east coast is related to improper sand management (including dredging and offshore or upland disposal of sand) at navigation inlets.

These and many more, are very simple precepts of coastal processes and management (or at least the authors think they are simple). But we see these precepts violated time and time again -- usually through in-

Figure 4. Dune restoration along central Cabbage Beach, c.1999-2000. Before (above) and after (below)



nocent ignorance, but sometimes by self-professed "experts" who have not tested their ideas against these truths and island experience.

BEACH RESTORATION AT ATLANTIS, PARADISE ISLAND

Most times when encountering beach management problems, mistakes in coastal development have are already made. The challenge then is to restore the damage, and to avoid repeating prior mistakes by others. Such has been the experience of Kernzer International at the Atlantis resort and Ocean Club developments along Paradise Island.

Prior early development at Paradise Island had sited buildings, seawalls and other infrastructure precipitously close to the sea. Sand permanently lost from the beaches during severe storms, such as by Hurricane David in 1979, was not replaced. The result was a gradual decrease in recreational beach area.

Toward remediation of this effect, Kerzner International undertook an extensive beach management program beginning around 1996. The beach was surveyed to establish a baseline of existing conditions. Dunes and native vegetation were established to cover those infrastructure items which were necessarily located close to the shore, where possible.

One of the most dramatic early measures was the demolition of the former Holiday Inn, at Pirates Cove. This structure had been built upon the rear part of the active beach, by others, about 30 years prior. Marginally successful attempts by the former hotel owners were made to reduce the wave energy entering Pirates Cove by construction of a submerged breakwater across the lagoon opening. A sheet-pile seawall was built in front of the hotel to protect it from beach erosion -- which ultimately exacerbated the loss of beach. This wall was progressively raised in elevation by concrete additions to reduce wave overwash. The remainder of the beach, particularly along the western reach, was progressively armored with more and more concrete structures and rock-filled gabion baskets.

Kerzner elected to destroy the hotel structure, clear the site, remove the seawalls, and restore the beach. (Figure 2) The objective was to allow the beach to return to a natural condition, and monitor its dynamic fluctuations. In this way, Kerzner might identify the appropriate seaward limits of future construction along this beach so as to avoid interference with the shore and to preserve the essential beach resource.

Significant works were likewise taken by Kerzner pursuant to Hur-

Figure 5. Limited damage to Cabbage Beach Dune after Hurricane Frances. (Photo: Sealey)

Figure 6. Close up showing resistance to erosion after rebuilding. (Photo: Sealey)

Figure 7. Beach Scraping on Cabbage Beach to accelerate natural rebuilding after Hurricane Frances . (Photo: Sealey)

ricane Floyd, in August of 1999. The storm caused extensive beach erosion and damage to oceanfront infrastructure. In repairing the damage, Kerzner elected to relocate as much of the prior infrastructure as landward as possible. Among other projects, these works included:

- demolition of damaged revetments and seawalls at the Paradise Paradise beach restaurant, and landward re-construction of the requisite revetments at the buildings' base, plus beach replenishment (beach fill);
- construction of a buried rock revetment – buried underneath the beach – along the sand spit between Pirates Cove and Paradise Paradise to repair the storm's breach to the spit, along with removal of the many years of prior shore protection debris, plus placement of beach fill;
- re-grading of the Phase One dune further landward so as to shift the dune further upland and to increase the available, dynamic beach width;
- construction of a rock spur on the lagoon entrance's east jetty, to 'anchor' the shoreline;
- protection of critical aquarium pump-house infrastructure by rock revetments buried deep under the re-graded and re-vegetated dune;
- removal of concrete steps and walkways seaward of the old seawall, with replacement by rock revetments and other steps cut back landward, into the seawall and pool decks (Figure 3);
- the island's largest beach renourishment project, ever, including placement of over 100,000 cubic yards of sand dredged from an approved, offshore site well outside the littoral system;
- removal of non-native dune vegetation, including casuarina, and placement of sand and a robust sea-oat and native dune vegetation program along thousands of feet of eroded dunes at Cabbage Beach (Figure 4); and
- landward relocation of damaged seawalls along the golf course at the island's eastern end.

These works were undertaken and completed within about five months or less after the storm's impact at a cost of many millions of dollars – testifying to the importance with which Kerzner views the beach resource.

REGAINING THE BEACH

There are many opportunities for beach improvements throughout the Bahamas, and particularly along New Providence Island. Central to these is to look for opportunities to remove encroachment of development and infrastructure from the beach. Wherever practicable, lands should be purchased, or existing public lands used, to relocate roads further from the shore – so as to give the natural sand beach ample room to develop. Seawalls that rou-

Figure 8. Private area on Cabbage Beach not owned by Atlantis and not rebuilt. After Hurricane Frances the dune shows considerable erosion (note foreground lip showing original extent) (Photo and caption: Sealey)

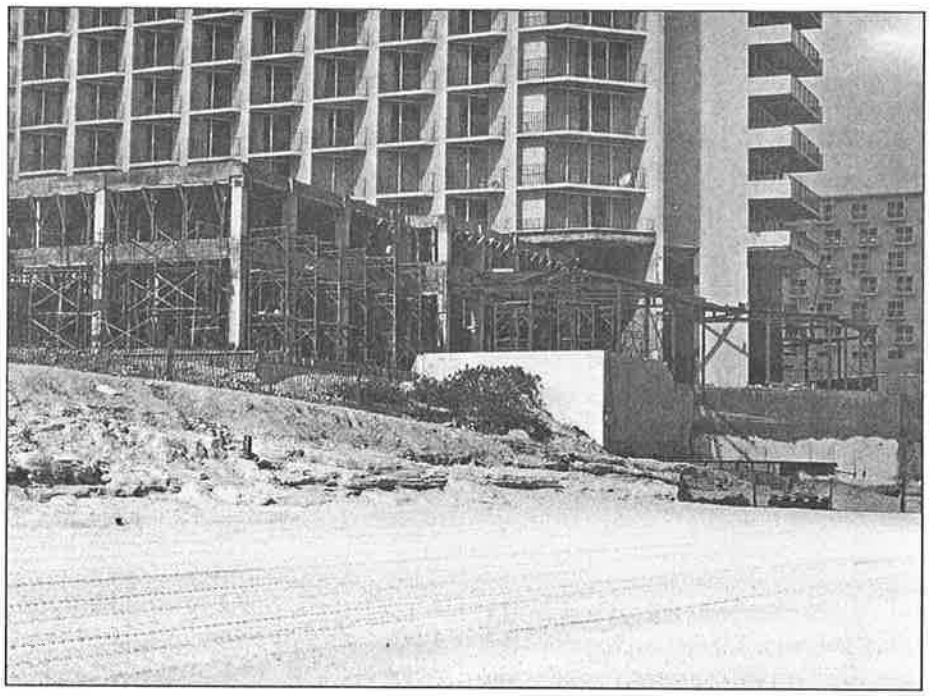


Figure 9. Intrusive rebuilding of Grand Hotel onto Cabbage Beach. Remnants of dune show extent of new construction, October 2004. (Photo and caption: Sealey)

tinely engage the ocean's normal tides should be relocated landward whenever possible. On the opposite extreme, new rock revetments placed along the coastal roadways protect the road, but destroy (displace) the beach as a result. As an example, this revetment approach has resulted in extraordinarily large-scale destruction of once-beautiful beach shorelines along many islands, especially in the State of Hawaii.

Beaches for the people of the Bahamas, and the islands' guests, are of critical importance and need. In most of these cases, the lack or loss of significant recreational beach areas appears to be due as much or more to long-term (and often continuing) encroachment of seawalls and structures along the natural sand beach as by any other physical cause. There exist physically and fiscally plausible means by which many of these beaches can be at least partly restored. While complex scientific studies are warranted in some situations, prudent coastal management -- founded as much or more in simple fundamental precepts than perhaps in complicated coastal-modeling and generic studies -- is the critical requirement to protect and regain these vital beach resources.

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