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Cover photograph – "Little Ricky" - juvenile dolphin, San Salvador, Bahamas (courtesy of Sandra Voegeli, 2003)

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SMALL HOPE BAY – THE CYCLE OF CASUARINA-INDUCED BEACH EROSION

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ABSTRACT

Sand loss leading to beach erosion has been a problem for decades in the Small Hope Bay area of North Andros. After hurricane Michelle immediate action was needed to protect property and maintain business at the Small Hope Bay resort. A study of the area from the air and on foot indicated long-term problems due to the building of minor structures such as groynes, and unrestricted growth of casuarina trees. The specific role of each factor was evaluated under long-term seasonal sea conditions as well as episodic storm events. Recommendations were made and implemented in order to stabilize the area. The use of gabions as a first line of defence was rejected. Dune reconstruction and reinforcement was undertaken and after one year the area is stable. A cycle of casuarina-induced beach erosion is proposed.

INTRODUCTION

Small Hope Bay is located north of Fresh Creek, Andros, on a small low headland with a sandy foreshore extending north and south. Reports of erosion in this area, and specifically at the hotel property, had been recorded some years before, but after hurricane Michelle in 2001 the situation became critical. (Figure 1)

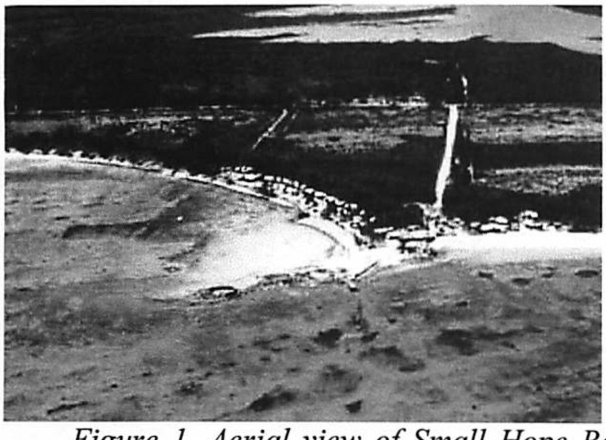

Figure 1. Aerial view of Small Hope Bay Resort looking west.

As a result of extensive sand loss and damage to buildings it was proposed to construct some form of protection immediately in front of the dining hall, and to undertake longer-term restoration and protection of the area. (Figures 2 and 3)

Figure 2. Main area of beach erosion.

Figure 3. Fallen casuarinas and erosion on south beach.

OBSERVATIONS

The site was visited in May 2002 and inspected from south to north. The southern section extending away from the property was a narrow beach area littered with fallen casuarinas and other trees, mainly coconut, whose roots pretty much extended to the shoreline. The next section going north, which fronted cabins on the resort property, consisted of a number of small bays separated by short groynes that had clearly been in place for some years. This area was separated from the northern section by a rocky point from which a wooden dock had been extended, and behind which the main facilities of the resort were located. It was this area that received the heaviest damage. The northern section consisted of a fairly wide beach, but this beach was itself divided according to the landscape immediately behind it. The first part fronted buildings and suffered severe erosion with sand being lost behind the buildings and in the car park and approach road. North of this area was a short section backed by smaller buildings set well back from the shore and also a line of natural but eroded sand dunes. The remainder of the beach extending some quarter mile to the north was backed by mature casuarinas, although at the furthest extremity erosion had caused the collapse of a number of trees. This section terminated at a rocky headland.

EROSION AND REMEDIES

The presence of the groynes indicated earlier erosion having been addressed. Despite this the buildings in this area are threatened, and the collapse of the casuarinas immediately south shows that beach retreat is progressive in this area. The proprietor's response was to add to the groynes, which indicate modest longshore drift in a southerly direction. However this was not recommended as it would starve other areas of the resort from much needed sand, and it is a symptomatic response that will not address the root of the problem, which is chronic sand loss. (Figure 4)

Figure 4. Erosion behind small groyne (in background).

In the critical area in front of the main facilities it was proposed to build a sea wall comprised of gabions. This was strongly advised against and has since been abandoned. Gabions are only suitable in the absence of wave action, such as training walls along river banks. Where they have been installed as sea defences at several places in New Providence and Eleuthera they have totally failed to prevent erosion and have contributed to further sand loss as well as becoming dangerous objects in themselves. Ultimately gabions in stainless steel baskets were used as anchors for rebuilt dunes in the heavily eroded areas, and an attempt has been made to plant native dune vegetation on the new dunes. In themselves these are unlikely to withstand heavy wave action, nor are they likely to build up naturally due to the lack of sand supply at present. (Figure 5).

Ultimately the evidence suggests that the entire area is sand loss induced by uncontrolled casuarina growth along the shore. Restoration of the beaches and sand dunes will require the removal of all the casuarinas and the replanting of native species to trap the

Figure 5. Collapsed gabion along West bay Street, Nassau, 2002.

sand. Solid material, if used to anchor rebuilt dunes, would stabilize them in the early stages, and relatively cheap material, such as chopped-down casuarinas, would be adequate. Gabions should also work but seem an expensive and unnecessary solution. Similarly buttressing the rear of rebuilt dunes would be worthwhile, and this has been done successfully with concrete walls in New Providence at the Poop Deck property at Delaporte, which has a similar narrow width of beach with which to work. Vigilance will be needed to prevent the rapid resurgence of casuarina growth. (Figure 6)

Figure 6. Rapid casuarina regrowth in new sand deposit.

In order to better understand the role of casuarinas in beach erosion, a cycle of erosion based on the Small Hope Bay situation was developed as a hypothesis for casuarina-induced beach erosion.

THE CYCLE OF CASUARINA-INDUCED BEACH EROSION

It is likely that the whole Andros shoreline at Small Hope Bay (and indeed much of the North Andros shoreline from Morgan's Bluff to Cargill Creek) has resulted from the evolution of an offshore ridge which ultimately created a mangrove swamp in the shallow and sheltered lagoon behind it (Figure 1) (Love & Boardman, 1991). This type of coastal development is common along the eastern shores of Bahamian islands, and has been recorded for Long Island and San Salvador (Mitchell & Keegan, 1988; Anderson & Boardman 1989), and for the north coast of New Providence (Sealey, 1994).

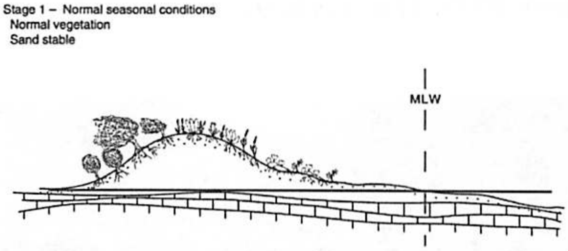

Figure 7. Normal weather and vegetation, stable dune and beach.

Stage 1: This represents the first stage of the cycle, prior to casuarina invasion. In times of heavy seas the beach sand is washed offshore and the front of the sand dune eroded, but as the sand is merely moved out into the bay it returns with the resumption of seasonal weather, and is again fixed in the dune by native species of dune vegetation, and the beach is built up by normal wave action. There is only a small portion of this stage left at Small Hope Bay, just south of the main buildings. (Figure 7)

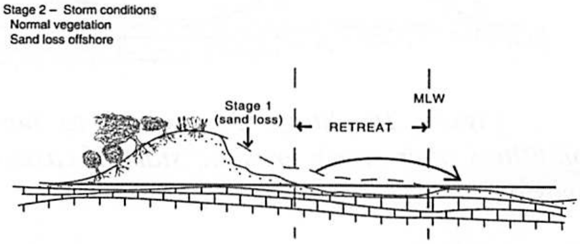

Figure 8. Stage 2: Storm conditions and beach/dune erosion under normal vegetation cover.

Stage 2: Within as little as a season, or as long as several years, the original profile will be regained with the resumed transport onshore of sand from the sea. With abundant vegetation the sand is trapped and with the aid of the wind the dune shore may be progressively widened. Long term monitoring of East Beach on San Salvador by various researchers on San Salvador (Beavers et al, 1995; Brill et al, 1993) shows how a well-vegetated dune encourages prograding, and an annual addition of some 10 000 cu metres of sand per kilometre of beach has been calculated (Anderson & Boardman 1989; Beavers et al, 1995). Recent studies indicate that progradation continues up to the present time, despite beach erosion from hurricanes Lili and Floyd in the intervening years (Godrey, Paul, pers. comm. 2003). (Figures 8, 9)

Figure 9. East Beach and dune on San Salvador, July 1990.

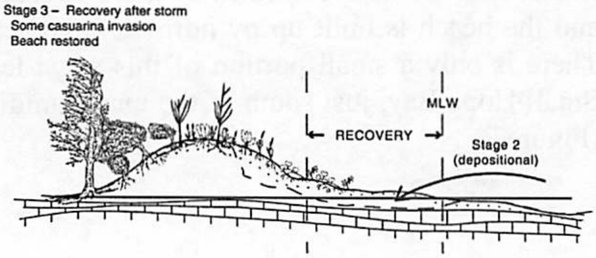

Figure 10. Stage 3.: Return to normal conditions after storm erosion, start of casuarina invasion.

Stage 3: With the introduction of casuarinas after recovery from storm damage, some of the dune vegetation is lost due competition for nutrients in this nutrient poor environment, and from being shaded out by the tall trees. In addition the litter of branchlets further inhibits the growth of young plants by smothering them. (Hammerton 2001) There is also some evidence for a toxic effect from the root system and/or the decaying plant litter (Craig, 1978). Whatever the exact cause, the result is that casuarinas start to dominate the beach vegetation. With severe beach erosion during a storm the dune is now less able to recover its natural vegetation and the casuarinas rapidly gain a commanding foothold. (Figure 10) .

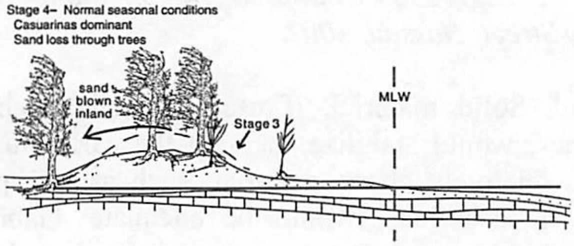

Figure 11 Stage 4: Casuarina invasion and loss of native ground cover, lowering of dune due to minor sand loss.

Stage 4: This is a quiet stage as far as beach development is concerned. Normal seasonal weather will not impact the beach adversely, but the stage is being set for later destruction. Casuarinas now rapidly take over the dunes and suppress the natural vegetation, completely covering the floor with their twiglets, and leaving only a fringe of native pioneer plants along the exposed foreshore. The dune is now somewhat flattened and dominated by casuarinas. Sand blown up from the beach between tides tends to be carried through the casuarinas instead of building up vertically, hence the flattened effect (Figures 11 and 12).

Figure 12. North beach casuarina invasion, loss of native vegetation and sand moving through trees.

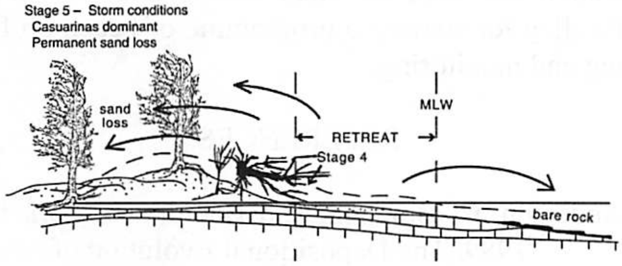

Figure 13. Stage 5: Storm conditions, massive loss of sand onshore through trees, further loss offshore.

Stage 5: Stage five results from the first severe storm after the takeover by casuarinas. Waves strip down the beach and pound the dune, but the dune is now lower and consists of bare sand between casuarina trees. As well as sand being washed offshore, and there will be much more of it exposed to wave action than when covered by native plants, the sand is now washed through the trees and ends up behind them. The result is the total removal of the dune system and the familiar exposure of casuarina roots. This is the situation all along the southern section of beach at Small Hope Bay, and also why the sand was washed through the buildings and access road during Michelle. Inspection of the casuarina stand south of the resort showed masses of sand carried through the trees and dumped in the swamp (Figure 13).

Figure 14. Beach sand piled up at rear of belt of casuarinas on north beach.

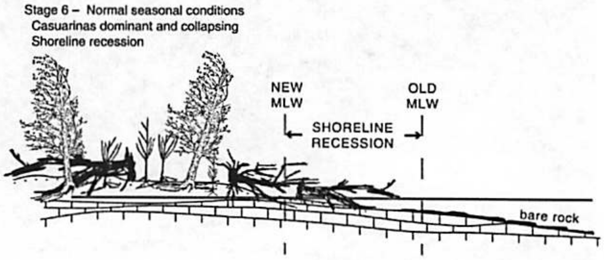

Figure 15. Stage 6: Normal weather, destruction of dune, casuarinas have collapsed into sea, permanent beach loss and shoreline recession.

Stage 6: The critical stage six has now been reached for continued beach destruction. The sand from the dune has been taken out of the system and dumped behind the trees, in this case in the swamp. With the return of normal weather conditions there is a deficiency of sand to rebuild the beach to its former extent, and the beach retreats landward, threatening all behind it. This is the stage now existing at Small Hope Bay in most areas, with no dunes and a retreating beach dominated by casuarinas (Figure 12). This can be a prolonged stage lasting as long as there is land left to be eroded. With each successive storm the beach shrinks until the casuarina tree line is reached, and fallen casuarinas lying in the sea are the hallmark of this stage, represented at Small Hope Bay by the area immediately north of the resort. Erosion does not stop at the tree line, but continues as the front trees are uprooted and washed away, only to be replaced by more sacrificial casuarinas. (Figures 14, 15 and 16)

Contrary to some opinions, the casuarinas are not protecting the beach, and it is unfortunate that many people think so, including professional agencies. In the last year I have noticed a report recommending their planting on Windermere Island, Eleuthera (Anonymous report), and a further report for Stocking Island, Exuma, stating: "It should be noted that if the area was not planted with Australian pine trees the erosion would be must (*sic*) more severe." (Ocean Caraibes, 2002).

Figure 16. Collapsed casuarinas, the final stage, north beach Small Hope Bay 2003.

CONCLUSION

Beach erosion is always due to sand loss in some form and can only be reversed by restoring or replacing the sand supply. Offshore dredging and beach sand stealing are clear causes for concern. Shoreline structures may cause beach erosion by redistributing sand, such as groynes which trap it on one side, or sea walls which deflect it offshore, or roads that truncate the dune system. Casuarinas and any other form of sand dune destruction will also cause sand to be lost from the system as described. This is widely recognized throughout the region, and reported (Craig et al) particularly in south Florida and the Florida Keys. Casuarina-induced erosion is unfortunately endemic on many islands, including Abaco, Andros, Grand Bahama and New Providence in particular, and gaining hold on most other islands, especially the more northern and wetter ones.

ACKNOWLEDGEMENTS

Much of the background to a study such as this owes a debt to many people over many years. I hope they will recognise their contribution and appreciate it.

More specifically the study was prompted and aided by Mr Jeff Birch the proprietor of Small Hope Bay Resort, and while he did not always accept my reasoning he has been a willing collaborator in trying to understand the underlying causes for the damage at Small Hope Bay, and has undertaken a variety of measures that will be monitored over the next few years. My wife Kathleen Sealey contributed to the fieldwork and is responsible with Mr Alex Alamo and Mr. Keith Bradley for starting a programme of beach profiling and monitoring.

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