THE STATE OF THE COAST:

REPORT ON ANDROS AND SOUTH ANDROS

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INTRODUCTION

Islands are, by their nature, only pieces of a larger whole. The past two decades have produced important research on island ecology in the tropical Atlantic that illustrates the integration of ecological function across land-sea boundaries, and the critical value of the coastal environments in stabilizing shorelines, processing pollutants, and supporting near shore production of important fisheries species. Unfortunately, islands of the wider Caribbean have been undergoing profound environmental change for over 500 years with human alterations of the coastal zone. A significant problem in the current development of coastal management policies and evaluation of environmental studies is the lack of synoptic method for the classification and ranking of human impacts for islands. This paper presents a method for characterization and assessment of the coastal zone in The Bahamas to address the status of Andros and South Andros Islands in terms of their ecological health.

It is possible to develop a new approach to coastal habitat classification based on objective characteristics that can be determined from remote sensing and field surveys. Comprehensive spatial datasets are beginning to guide field surveys to assist with the location of new development or infrastructure needs, assist in the design of protected areas, reserves and parks, as well as identify areas for coastal restoration.

The coastal zone is a sensitive area where the land meets the sea. It includes areas of wetlands, dunes, beaches, rocks, low cliffs, bays, and coves. Resource managers have long recognized the importance of integrated coastal zone management to balance human needs with long-term environmental protection (Windevoxhel *et al.* 1997, Sealey & Bustamante, 1999). The coastal zone is dynamic, meaning it is constantly changing its shape due to currents, waves, tidal changes, storms and hurricanes. Because of its island nature, The Bahamas is essentially all “coastal zone,” and few places are far from the sea. Most people live within 2 kilometers of the sea, and because of the pattern of settlement, and the nature of the economy, this is undoubtedly the most important of all the environments.

The changes that humans cause in the coastal zone are often integrated or exacerbated by natural variability in this dynamic environment. There are two types of events that naturally alter coastal geomorphology and ecology: 1.) Acute and catastrophic events to the system such as major storms (which are natural) or large-scale construction events such as dredging and coastal fill (which are not natural), and 2.) Long-term chronic changes to coastal systems stem from climatic cycles change (which can be natural, though humans can alter global climate patterns), and gradual degradation from coastal nutrient loading, loss of coastal vegetation and increased sedimentation with land cover change (see Table 1) This paper outlines an inventory and ranking system that looks at chronic stressors to the coast of Andros and South Andros.

METHODS

In 2002, a classified map of the land cover and near shore marine habitats of Andros Island was completed as part of the Caribbean Land Sat Vegetation Mapping Initiative (See Sealey et al. 2002). This map was created to characterize the coastal environments of Andros. Coastal areas can be characterized in terms of: 1.) Sediment type, 2.) Wave and wind energy, 3.) Coastal vegetation structure, and 4.) Coastal type. These characteristics are related, and allow us to apply a uniform nomenclature in naming coastal segments based on basic information provided.

Sediment type

Consolidated sediments form characteristic “iron shore” cliffs and rocky platforms. Some beaches can include beach rock or small rocky tambolos, but the classification of the shoreline sediments looks at the large scale characteristics (over 1 km) of the coastal environment as dominated by rocky shores and cliff (consolidated sediments) or dominated by sands and muds (unconsolidated sediments).

Wind and Wave Energy

Coastal environments are essentially linear features, but vary in width and length depending on topography of the adjacent seafloor and landform. The prevailing winds in the Bahamas are from the east-southeast, thus low-energy coastal environments include the western shorelines of islands protected from prevailing winds, and sheltered by large areas of the shallow banks. Low energy coasts can also occur in protected lagoons, bays or mangrove creeks anywhere on an island. Medium energy shorelines are along the north or eastern shore of islands, with some protection for offshore reef crests or cays. High-energy coastal environments can be narrow bands along the platform margin of banks with precipitous walls at the platform margin, and steep cliffs or rocky headlands.

Natural vegetation community

Regional plant ecologists developed a Caribbean vegetation community classification in 1999 (Areces-Mallea et al. 1999). This classification is hierarchical, and provides simple guidelines for designation of vegetation structure by height and canopy cover. The coastal vegetation communities can be identified to the formation-level with assessment of vegetation structure and type, with some dominant plant species identified. Dunes can be grassy or shrubby, and forests or woodlands are described as evergreen broadleaf formations, locally referred to as “bush” or “coppice”.

Human impacts can alter the coastal environment in four basic ways: 1.) Physical restructuring of the shoreline by dredging canals, marinas or filled areas, 2.) Destructive use of the coastal zone with vegetation loss from sand mining or dumpsites, 3.) Coastal development and vegetation replacement, and 4.) Volunteer invasion of alien plants from seed dispersal mechanisms. Often the coastal alterations could have occurred long ago (decades), so it is our challenge to try to understand how the coastal zone has changed, and ask, ”What is the history of human occupation and use of the area?”

The overall score of human impacts to the coastal zone is a compilation of the four separate parameters. The most destructive impact to coastal areas involved physical restructuring of the shoreline by dredge and fill. This includes bulkheads, sea walls, groins and jetties. The coastal segment, classified as all one type of coastal environment is assessed. How much of the coastal extent has been physically altered? From an ecological perspective, physical restructuring can have a profound impact on the coastal processes. For all of the impact criteria, over 70% of the linear extent of the shoreline altered is considered “severe” impacts; over 50% is “high”, and over 10% in “medium”, and less than 10% of the coast physically altered would be a “low” impact area. Often aerial photographs or satellite images can determine the extent of physical restructuring. However, there are historical changes such as massive conch shell middens, causeways, and historic coastal roads that need field surveys to understand and assess extent of impacts.

The second most harmful impact on coastal environments is the removal or loss of native vegetation. In addition to the loss of terrestrial habitats and biological diversity, removal of coastal vegetation has its most immediate impact on the near shore marine communities. Near shore marine flora is comprised of two major components: algae and seagrasses. Many studies have stressed the importance of near shore communities as settlement sites for marine fauna. Shenker et al. (1993) determined that many commercially important groupers and snappers need the shallow nursery areas adjacent to islands to complete their life cycle. Often the vegetation is lost initially through clearing of the land for building, but often, the clearing is abandoned, with invasive alien plants dominating the regrowth. Most removal is the result of roads and sand mining. Islands require sand for construction and building, but there are limited sources for this critical resource.

The ranking of coastal development looks at the occurrence of building along the coast within 200 m of the shoreline. Often, developments and resorts have vegetated coastal zones, but gardens and lawns replace native vegetation. This ranking parameter does not take into account the presence or size of coastal setbacks, as coastal setbacks are rarely observed in The Bahamas. The ranking looks only at the linear extent of the coastal segment where any structure (houses, hotels, or abandoned buildings) is within 200 m of the shoreline, and most of the surrounding vegetation is garden, lawn or weedy plants that have replaced native vegetation communities.

Two species of introduced invasive plants are able to propagate by sea-borne seeds. The Australian pine (*Casuarina equesetifolia)* and the beach naupaka (*Scaevola sericea*) are considered a threat to the stability of the coastal zone and to native plant diversity but the Government of The Bahamas. Both species are considered invasive pest plants in Florida, and are actively removed from dune areas. The sea borne seeds of these two species can invade even intact and otherwise unaltered coastal segments.

The combined impact assessment produces a final overall coastal ranking score. This score indicates the ease of remediation. Low or Medium impact ranks represent areas that can be improved by local stewardship actions, such as invasive plant removal and some modest coastal restoration measures. High and Severe impact scores the necessity for larger-scale and higher-cost measures, such as backfilling dredged canals and physical restructuring of the shoreline environment.

RESULTS AND DISCUSSION

The overall rankings for 67 survey sites along the coast of Andros show most of the coastal zone has a low to medium impact ranking. 41% of the survey sites were Low impact areas. 35% were medium impact; 16% were high impact areas, and only 8% severely impacted. Most of the high to severely impacted coastal areas were in Northern Andros with the exception of Driggs Hill, South Andros. Much of the South Andros was "Low" to "Medium" impact.

The most remarkable finding was the almost ubiquitous presence of Australian pines in the coastal zone, for all coastal types (sand, rocky or mangrove). The "Severely" impacted sites were all areas with massive coastal restructuring for the development of a marina or harbour. There was no apparent mitigation in these areas with the replanting of native coastal plants or engineering to prevent run-off or erosion.

The degree of alteration and damage to the coastal zone of Andros is surprising given the small population density and limited commerce to the island. Much of the damage was historic, and the degradation has only increased with time. The people of Andros face serious challenges in coastal protection with small settlements and limited stewardship resources. Communities need to find new partnerships to help control and eradicate invasive plants in the coastal zone, as well as begin to explore large-scale mitigation efforts to restore coastline stability in areas such as Fresh Creek.

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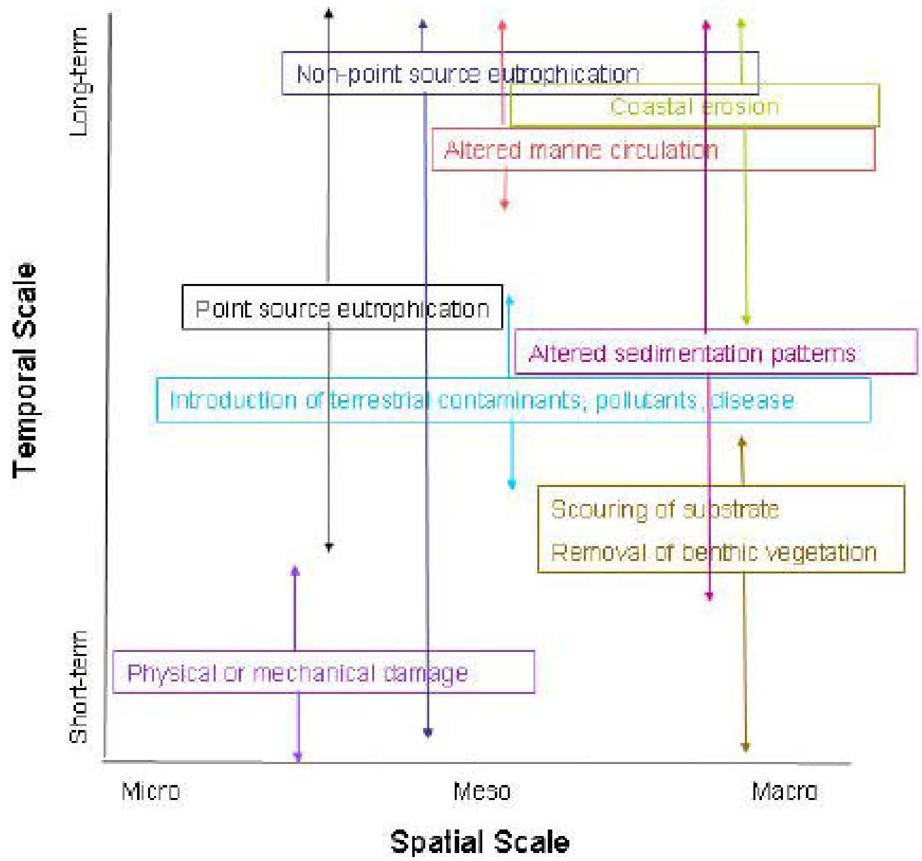

FIGURE 1: Spatial and temporal complexity of disturbance regimes to coastal environments.

Table 1: Consequences of disturbances on coastal environments. Note that this is not an exhaustive list, but provides some of the more common agents that are relevant to Bahamian systems.

Disturbance	Agent and Potential consequences	References
Hurricanes and storms	• Physical and mechanical damage or death • to organisms • Altered sedimentation patterns • Coastal Erosion • Scouring of substrate • Removal of benthic vegetation • Eutrophication and phytoplankton blooms • Introduction of terrestrial contaminants, • pollutants, disease • Altered water quality (e.g. pH, dissolved • oxygen, turbidity)	Littler et al. 1983, Perret et al. 1993, Tilmant et al. 1994,Lirman & Fong 1997, Wesseling et al. 1999, Adams 2001 Tilmant et al. 1994, Nyman et al. 1995, Stone et al 1997, Swiadek 1997, Parsons 1998, French 2001 Tilmant et al. 1994, Nyman et al. 1995, Stone et al 1997, Swiadek 1997 Thomas et al. 1961, Pimm et al. 1994, Tilmant et al. 1994, Adams 2001, Keen et al. 2002 Thomas et al. 1961, Tabb & Jones 1962, Valiela et al. 1998 Pimm et al. 1994, Tilmant et al. 1994, Valiela et al. 1998 Tilmant et al. 1994 Andrews 1973, Pimm et al. 1994, Sousa 2001
Physical alteration of the shoreline	• Increased sedimentation • Loss of natural shoreline structural • integrity and stability • Increased particulate matter and turbidity • Altered oceanographic/circulation features	French 2001
Coastal vegetation removal or modification	• Eutrophication • Increased sedimentation and coastal • erosion • Habitat loss • Decreased shoreline and dune	Dubinsky & Stambler 1996, Peterson & Estes 2001, ISRS 2004 Dubinsky & Stambler 1996, Peterson & Estes 2001, ISRS 2004

	stability	Buchan 2001
Agricultural plots or golf courses	• Rapid eutrophication via fertilizer run-off • Introduction of pesticides and fungicides • to coastal waters	Buchan 2001 Dubinsky & Stambler 1996, ISRS 2004 Sealey 2002
Coastal homes, businesses, roads	• Eutrophication • Introduction of pollutants and disease	Dubinsky & Stambler 1996, Sealey 2002 Clark 1998
Sand-mining	• Shoreline erosion	Dubinsky & Stambler 1996, Clark 1998, Buchan 2001

Table 2: Results of the coastal impact characterization and assessment for Andros and South Andros islands. The date of the assessment is given along with Shoreline characteristics, human impact scores, presence of invasive plant species, and overall coastal impact ranking.