Comparison of Tropical Barrier Island Chains on Leading Edge (Colombia) and Trailing Edge (Brazil) Coasts

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ABSTRACT

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In Colombia 63 barrier islands exist along a 800-kilometer reach of the Pacific Coast. In Brazil roughly 50 barrier islands are found along a 570-kilometer stretch of coast immediately south of the mouth of the Amazon River. Both island chains are deltaic and have a large sand supply furnished by numerous relatively small rivers. The Colombian Islands are longer, averaging 10 km, compared to a typical length of 1 to 4 km for the curved Brazilian Islands. Tidal amplitudes hover around 4 m for the Colombian coast but the islands are able to extend across estuary river mouths to form a continuous interconnected chain as far as sand supply is concerned. The Brazilian Islands are faced with a 4 to 7 m tide range and, as a consequence of strong tidal action, the islands are not connected in terms of sand supply. Instead, the islands are plastered on the ends of deltaic sediment lobes. Rare tsunami events and a huge sediment supply, characterize the evolution of the Colombian Islands. New islands form as the Brazilian sediment lobes build seaward, apparently leaving behind a band of cheniers a few kilometers wide.

INTRODUCTION

Two distinct chains of barrier islands occur on opposite coasts of South America near the equator. On the Colombian Pacific coast, 63 barrier islands exist along an 800-kilometer reach of coast north of the equator. On the Brazilian coast, around 50 barrier islands exist along a 570-kilometer stretch of coast. The islands differ considerably in terms of morphology, sand supply and oceanographic conditions. Of particular importance is the difference in tidal amplitude. The Brazilian islands, with a maximum tidal range of 7 meters, may exist in the highest tide conditions of any barrier islands in the world.

Both island chains are in remote areas. Few of the individual islands are accessible by road. A single large community (Tumaco) exists on the Colombian Islands. The remaining developments are small fishing villages of 200-300 individuals. A number of larger towns exist on the Brazilian Islands, usually centered on tourism.

The leading edge Pacific coast of Colombia is tectonically highly active, which is reflected in the nature and evolution of the islands. The fact that new barrier islands are forming to the seaward of the current barrier island chain in some places in Brazil is a reflection of the much lesser importance of tectonic activity on this trailing edge margin.

COLOMBIA’S BARRIER ISLAND COAST

Sixty-two islands exist along the coast of Colombia. The number of studies of these barrier islands can be characterized as sparse. They include GONZALEZ and MARIN (1989); MARTINEZ and CARVAJAL (1990); CORREA and LOPEZ-RENDON (1991); MARTINEZ, et al. (1995 and 2000) and CORREA and GONZALEZ (1998). The islands are covered by tropical rainforest and backed by mangrove forests. They line the seaward margin of a narrow deltaic plain formed from rivers draining the nearby northern Andes. In some cases, apparently as a result of island migration, mangroves cover the entire island, which makes their delineation, even with aerial photographs, difficult. That is, the island/lagoon boundary has no vegetative basis for delineation.

This is a mesotidal coast with average tidal ranges between three and four meters. Spring tide ranges are from four to five meters. Wave energy is moderate and waves impacting on the beach are often much higher at high tide than at low tide due to offshore bars. The high tidal amplitude is responsible for “horn” and “elbow” tidal deltas; long bars extending up to 10 km offshore. New inlets apparently form during spring tides. Storm overwash is common, but not at the scale observed on non-tropical barrier islands. The heavy vegetative cover holds back overwash penetration. Large differences in tree size, and in the degree of topsoil development, reflect differences in the evolutionary history of the islands. Many appear only a few decades or centuries old.

Two of the islands, Isla El Soldado and Isla Santa Barbara, forming the Mucay, Naya, and Anicun, Raposo and Anichayu Rivers’ delta plains were studied in detail (Figure 1). All the islands are of low elevation, less than 2 meters above spring tide level. Isla El Soldado is mostly 50-60 meters wide and rarely more than one meter in elevation. Trees are small and a soil profile is totally missing. Buried trash that floated out of nearby Buenaventura Bay was found buried a full one meter below the normal high tide line. Since the trash probably originated in the mid 1950s or early 1960s, this particular island is less than 50 years old. Comparative aerial photography indicates that much of the island has migrated off its 1950s footprint.

While Isla Santa Barbara is wider, slighter higher and has a well-developed soil profile with larger trees that are probably more than 100 years old. This island has a dramatically different subsidence history than its neighbor Isla El Soldado that has subsided at a rate of 10 feet/century over the last few decades.

Ironically, the stable Isla Santa Barbara has no village on it, but the village of El Soldado exists on the island of El Soldado and is in serious erosion trouble. The sand constituting the Colombia islands is immature, reflecting its recent derivation from the nearby Andean mountains.

It is dark-colored, rich in rock fragments and often highly micaceous. The high mica content gives local beaches a sparkly appearance.

Sand supply is generally high, and local waves generally transport sand from south to north. Wave energies and sand supplies are sufficient to build spits across the mouths of rivers and estuaries. Locally, sand supplies may become temporarily deficient as river mouths switch and spits are eroded.

Most of the islands are transgressive in nature. Island
Soldado and Santa Barbara were studied in detail.

Figure 1. A portion of the Pacific Coast of Colombia showing islands where different and more numerous species of against mangrove-covered headlands. Unlike Colombian islands separated by the Rio Gurupi shown in Figure 2.

The islands are in the states of Para and Maranhao, which are capped at its seaward end by curved barrier islands (Figure 2).

Belem. This coast displays a strange, jagged sawtooth pattern the Equator and the southern branch of the Amazon River at south (, 2003). They are situated immediately south of islands across river mouths. Much like the Colombian islands, catastrophic storms such as hurricanes are absent, and the impact of storms here will depend highly upon the stage of the tide.

The islands have well developed ebb tidal deltas, but poorly developed flood tidal deltas. The shelf offshore is wide, on the order of 150-250 km (, et al. 1974). Overwash apparently is frequent on these islands and dune development, in some cases, is extensive; again unlike the Colombian islands. Most of the delta lobes are capped by a several-kilometer wide band of cheniers, indicating a general progradation of the barrier island shoreline (SOUZA FILHO and EL-ROBRINI, 2000; SOUZA FILHO and COHEN, 2003). The cheniers have the same curvature as the current barrier islands.

Sediment is fine-to-medium sand size with variable and sometimes high shell content. Beach sand here is much more mature than Colombian island sand. Dominant minerals are quartz and feldspar, and the color is a light gray to a light yellow-brown. The source of the sediment is unclear. Most Amazon-derived mud and sand either moves offshore or to the north. Mineralogical studies will be required to answer this question.

Among global deltaic barrier islands, those of northern Brazil most closely resemble the island chains formed at the end of the lobes of Mekong Delta. On the Mekong, the sand supply is larger and the band of cheniers is fully 50 km or more in width.

BRAZIL’S BARRIER ISLAND COAST

Fifty islands stretch along the 570-kilometer Brazilian shoreline, between Marajo Bay and Sao Marcos Bay to the south (PILKEY, 2003). They are situated immediately south of the Equator and the southern branch of the Amazon River at Belem. This coast displays a strange, jagged sawtooth pattern with the teeth of the saw being dozens of small headlands, each capped at its seaward end by curved barrier islands (Figure 2).

The islands are in the states of Para and Maranhao, which are separated by the Rio Gurupi shown in Figure 2.

The islands are thin, one to four km long and are plastered up against mangrove-covered headlands. Unlike Colombian Islands where different and more numerous species of mangroves exist, mangrove trees do not cover the uplands here. Almost all the islands are curved, and there is no lateral connection between islands on adjacent headlands. In this sense, this is not a true barrier island chain.

The curvature indicates that there is probably no strongly dominant direction of longshore transport here. Tidal amplitude is very high, ranging from four to six meters, perhaps the highest for any barrier island group in the world. Undoubtedly, the high tidal amplitude is responsible for the lack of build out of barrier islands across river mouths. Much like the Colombian islands, catastrophic storms such as hurricanes are absent, and the impact of storms here will depend highly upon the stage of the tide.

The islands have well developed ebb tidal deltas, but poorly developed flood tidal deltas. The shelf offshore is wide, on the order of 150-250 km (, et al. 1974). Overwash apparently is frequent on these islands and dune development, in some cases, is extensive; again unlike the Colombian islands. Most of the delta lobes are capped by a several-kilometer wide band of cheniers, indicating a general progradation of the barrier island shoreline (SOUZA FILHO and EL-ROBRINI, 2000; SOUZA FILHO and COHEN, 2003). The cheniers have the same curvature as the current barrier islands.

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CONCLUSIONS

The equatorial tropical barrier island chains of Colombia and Brazil reflect differences in the tectonic and oceanographic settings. In both Brazil and Colombia, the islands are remote and only lightly studied at best. Both island chains are deltaic, formed from sand derived from numerous small rivers. The Colombian sand is immature, derived from the nearby Andes, and the Brazilian sand is mature, derived from sources far inland. The transgressive nature of the Colombian islands reflects a tectonically active environment with high relative sea level rise and tsunami sedimentation constituting an important component of island evolution. The Brazilian islands, in a
trailing edge environment, show little indication of tectonic influence, and the impact of sea level rise here is minor.

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LITERATURE CITED


