Regional Coastal Processes

Pinellas County is situated at the north end of the west-central Florida barrier-inlet complex, which is bounded to the north and south by marshes and mangrove mangals, respectively. This low-energy region is subjected to mean wave heights of about 0.3 m (Elko and Wang, 2007) and an average tidal range that is less than 1 m (NOAA, 2004). Dunes are also small on the natural portion of this coast, generally less than 3 m, due to low average wind speeds and low sediment supply. Along most of this region, the original dunes were removed in the process of urbanization.

The low wave height and tidal range values result in a mixed-energy coast that displays a great diversity of barrier island morphologies (Davis, 1994). Some regions exhibit classic wave-dominated barriers, with long, narrow islands and few tidal inlets, whereas other areas have short and wide, drumstick barriers with closely spaced tidal inlets. The varied morphology is a product of the relative influence of waves and tides (Davis and Hayes, 1984; Davis, 1989a) in which small changes in the influence of either parameter can result in significant changes in barrier island morphology.

Sediment along the west coast of Florida has a bimodal distribution of predominantly fine quartz sand and gravel-sized carbonate that is mostly bivalves (Davis, 1994). The siliciclastic sediment originated in the southern Appalachians and the carbonate shells are produced in situ. Presently, this is a sediment-starved system in terms of terrigenous material (Davis, 1997).

The typical weather conditions along this coast consist of prevailing breezes from the south during the summer. These summer conditions cause moderate longshore sediment transport from south to north. During the winter, cold fronts approach from the northwest about every seven to ten days. The passage of cold fronts generates relatively high-energy wind and wave conditions, with breaking wave heights of about 1 m and strong longshore sediment transport to the south. It is not uncommon for these weather conditions to persist for 48 hours or more.

The continental shelf off the west-central coast of Florida is broad and flat with a slope of about 1:1,000. The combination of this wide shelf and the fetch-limiting Gulf of Mexico results in depth-limited waves at the coast. The general northwest approach of wave energy drives regional net longshore sediment transport to the south. Several local reversals in sediment transport (Davis, 1994; 1999), as well as significant longshore transport gradients, result from variations in nearshore bathymetry and shoreline orientation.

Occasionally, tropical storms impact the west coast of Florida. It is rare for a hurricane that entered the Gulf of Mexico from the southeast to turn abruptly to the east/northeast and impact the west coast of Florida. In fact, the last time a hurricane made direct landfall in Pinellas County was 1921. During the hurricane season of 2004, four strong hurricanes made landfall in Florida. This tied the 1886 record with Texas for the most hurricanes to hit one state in a single season (Bell et al., 2005). The 2004 hurricanes made landfall at some distance from, but with significant effects to, Pinellas County beaches.

Google Earth satellite image of Florida showing the coastal provinces of Florida

Pinellas County's Federal Beach Erosion Control Program

(Shore Protection Project: SPP)

Background

Railroads brought northerners to Florida's coastal towns in the late 19th century and the beaches were developed shortly thereafter. Modern development of Pinellas County's barrier islands began in the 1920s when causeways were built to connect the barriers to the mainland. Early beachfront development was unregulated and often resulted in destruction of the natural dune system and construction too close to the beach. This development essentially stabilized the naturally dynamic barrier islands, resulting in a beach erosion "problem" as described in the introduction.

Even the natural barrier islands along the Pinellas County coastline often contain historical or recreational structures. Parking lots and bathhouses on Honeymoon Island and the historic Fort De Soto on Mullet Key are fixed structures that have given way to beach erosion issues.

Throughout the 19th and 20th centuries, both natural and human-induced changes occurred along the barrier islands. The hurricanes of 1848 and 1921 breached new tidal inlets at John's Pass and Hurricane Pass. In the 20th century, many inlets experienced significant changes in tidal prism due to dredge-and-fill and causeway construction in back-barrier bays. Both the natural and human changes contributed to destabilization of certain inlets and migration in the direction of longshore sediment transport.

The combination of unregulated coastal development and the destabilization of many tidal inlets led to significant beach erosion issues in the mid-20th century. Beachfront homeowners attempted private shore protection by building seawalls and short groins. Regional sediment transport patterns were not considered in these efforts and many of the private structures were not successful. By the 1960s, much of Pinellas County's coastline had eroded to the seawalls. No sandy beach remained along the majority of the developed shoreline.

Looking north along the southern portion of the Pinellas County coastline at the short, wide drumstick barriers with closely spaced tidal inlets. The barriers shown are from south to north: Mullet Key (Fort De Soto Park, shown here with a small breach), Shell Key, and Long Key (distant background).