Evolution of a Tidal Inlet

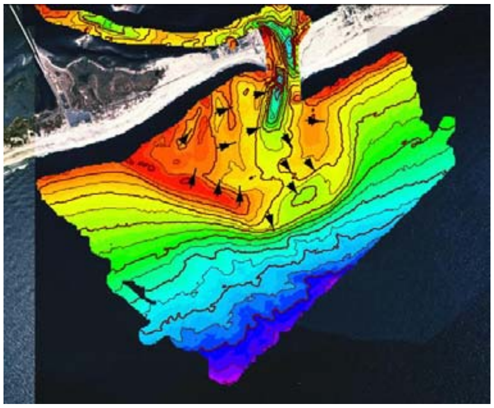
Because of the discoveries of New York Sea Grant researchers regarding sedimentation at a tidal inlet, state and federal officials are reassessing the management of Shinnecock Inlet, an economically and environmentally important waterway on the south shore of Long Island, NY.

A primer on dynamic tidal inlets

Along parts of the Atlantic coast, it has been estimated that as much as 80 percent of coastal erosion results from the interruption of longshore sediment transport at tidal inlets. The impacts of inlets can be exacerbated by attempts to stabilize these features for navigation purposes by dredging or building of structures if these activities are not implemented properly with a clear understanding of the important coastal processes and sediment transport pathways. Problems associated with maintaining navigation at inlets while minimizing erosion on adjacent shores are experienced worldwide.

Sediment transport near tidal inlets is quite complex. It involves the combination of waves and currents superimposed upon the dynamic water depth, or bathymetry, of the surrounding coastal area. Tidal inlets on open ocean coastlines provide a channel for sand movement into coastal bays, flood tidal deltas, and marshes. The net movement of sand into the back barrier lagoon or out the main inlet channel is controlled by flood- and ebb-tidal currents. In so doing, tidal inlets remove sediment from the longshore drift.

Unstabilized inlets often allow sand in the longshore transport system to bypass the feature and make it to the down drift shoreline. Bypassing at stabilized inlets is less well understood. There are two transport mechanisms currently theorized to be associated with natural sediment bypassing at tidal inlets; continuous or discontinuous.



A high-resolution bathymetric survey at Shinnecock Inlet, NY. Arrows indicate the direction of apparent sediment motion based on the movement of sand bodies. Map courtesy of D. Conley and R. Flood.

Continuous bypassing has been associated with ebb tidal shoals. Waves and tidal currents drive the longshore transport around the peripheral edge of the ebb tidal shoal and thus around the inlet. In this scenario, sand is transported to the down drift shoreline. Discontinuous inlet sediment bypassing occurs along a mixed energy shoreline (tidal and wave influences) and involves the episodic migration of sand bars formed on the down-drift side of the ebb tidal shoal. This results in the sporadic bypassing of discrete packets of sand.

Investigating Shinnecock Inlet

Recent research has shown how inlet bypassing on a tidal inlet with an ebb tidal shoal is predominantly of a continuous nature although discontinuous processes seem to exist. It is likely that the discontinuous processes may dominate in an area where the ebb tidal shoal is disturbed by dredging. Understanding if this is true and how bypassing occurs on such an inlet may provide management strategies to minimize impacts to down-drift shorelines. To investigate the sediment bypassing properties at such a manipulated tidal inlet, the research team of Daniel C. Conley and Roger D. Flood from the Marine Sciences

Research Center, Stony Brook University, used Shinnecock Inlet, located on the south shore of Long Island, NY. This team conducted detailed observations of the seabed evolution using a high-resolution multibeam bathymetry system. In order to perform numerical investigations of the sediment bypassing processes at Shinnecock Inlet, this team modified numerical models of near-shore circulation to be able to make detailed predictions of seabed evolution.

New survey techniques yield previously undetected dynamism in the Inlet

Sequential high-resolution bathymetric surveys at Shinnecock Inlet indicated that the ebb-tidal shoal accumulated sediment at a rate of about 440,000 m^3/yr with much of the material accumulating in deeper water. This observation differed from findings by the US Army Corps of Engineers (USACE) consultants who found that the volume of the ebb-tidal shoal had not changed in recent areas based on historic surveys. Based on that limited information, they had concluded the inlet had reached a dynamic equilibrium and was no longer disrupting the natural longshore transport of sand.

The discrepancy may be due to uncertainties in vertical datums for USACE surveys and the fact that USACE surveys generally did not survey the seaward face of the ebb-tidal shoal. The multibeam bathymetry studies suggest that about a quarter of the growth of the ebb-tidal shoal has been in water depths greater than about six meters on the seaward face of the shoal, and surveys that do not include this area will not correctly characterize the evolution of the ebb-tidal shoal. This detailed bathymetric change data will be used along with the revised flow and sediment transport models to ensure that model predictions agree with observed changes.

NYSG's coastal processes specialist, who is a member of the NYSDOS's State Inlet Advisory Committee and the US Army Corps of Engineers New York District Coastal Technical Advisory Committee, realized the data from the new surveys contradicted assumptions being made in the development of a comprehensive management plan for New York's ocean inlets. Through participation in these technical committees, NYSG was able to extend this information to state and federal officials who used it to make a decision to re-evaluate the $2 million inlet management planning effort. NYSG has been asked to assist in this reassessment.

Students

Two students worked on this research project. Ms. Charlene Sullivan graduated from the Marine Sciences Research Center, Stony Brook University, with a Master's degree in September of 2005. She then began work as an Oceanographer for Integrated Statistics located in Woods Hole, MA. Ms. Lijuan Huang graduated from the Marine Sciences Research Center, Stony Brook University with a Master's degree in September 2005. She worked with the multibeam data from the survey studies and is currently an intern at NOAA.

Publications

Ferrini, V.L. and R.D. Flood. 2005. A Comparison of Rippled Scour Depressions Identified with Multibeam Sonar: Evidence of Sediment Transport in Inner Shelf Environments. *Continental Shelf Research* 25:1979-1995.

Huang. L. 2005. Characterizing Bathymetric Change Patterns of Ebb-tidal Delta at Shinnecock Inlet, Long Island, NY, Master's Thesis, Stony Brook University. 61 pp.

Sullivan, C. 2005. Effects of Waves and Tides on Residual Circulation at a Modified Inlet. Master's Thesis, Stony Brook University. 124 pp.