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Sediment transport pattern at the Barra Nova inlet, south Portugal: a conceptual model

Abstract The Barra Nova inlet, in south Portugal, is known to migrate progressively southeastwards under wave action. The morphodynamics of this system during a representative year suggests that this long-term evolution is dependent on a seasonal behavior of the tidal inlet which can be described through a three-stage model of post-storm, transition and extended fair-weather conditions. Processes involved in this evolution indicate that the historical migration of the Barra Nova is not dependent on the longshore drift forcing constricting the channel on the updrift coast, but rather on the adjustment of the system to a major erosion of the downdrift coast during short storm events.

Introduction

Sand transport pathways, sediment budgets and the consequent morphological evolution of tidal inlets (and associated deltas) have been studied extensively over past decades (e.g., Hayes et al. 1970; Oertel 1975; Hine 1975; Hubbard 1975; FitzGerald et al. 1976; Hayes 1980; FitzGerald 1996; Komar 1996; Kana et al. 1998). Sediment transport processes are well known to be closely linked to the combined action of tidal currents constricted by the inlet and local wave climate. Depending on the relative influence of tidal currents and waves, tidal inlet shoals evolve through several stages of channel/bank migration which control their stability and the durability of the inlet. Tidal inlet currents interrupt wave-induced longshore sediment transport (FitzGerald 1982), affecting adjacent beach sedimentation processes and the formation of shoals and deltas on both sides of the inlet throat. Sand bypassing occurring at tidal inlets has been widely studied, and numerous conceptual models have been proposed. Most of these models are based on the pioneering work of Bruun and Gerritsen (1959), Bruun (1966), and FitzGerald (1982). In a recent review by FitzGerald et al. (2001), six conceptual models have been highlighted to explain the evolution of natural tidal inlets and sediment bypassing (Fig. 1).

Model 1. Stable inlet processes. A stable inlet has a stationary inlet throat and a static main ebb channel position through the ebb-tidal delta. Bypassing at these inlets occurs through the formation, migration, and attachment of large bar complexes to the downdrift shoreline.

Model 2. Ebb-tidal delta breaching. Ebb-tidal delta breaches occur at tidal inlets which have stable throat positions, but whose main ebb channels cyclically migrate downdrift. Sediment accumulation on the updrift side of the ebb-tidal delta causes a downdrift deflection of the main ebb channel, and tidal flows at the inlet become hydraulically inefficient. Breaching occurs on the updrift swash platform, a new channel being cut in the process. The abandoned channel gradually fills with sediment deposited by tide- and wave-generated currents. The breaching process commonly results in the bypassing of a large portion of the ebb-delta sand.

Model 3. Spit breaching by inlet migration. Sand transported along the coast and deposited in the tidal inlet constricts the inlet throat by decreasing the channel cross-sectional area. As a result, the inlet migrates in the downdrift direction, the inlet channel becoming progressively longer. This increases the frictional resistance of the tidal flow, and thereby reduces the tidal range in the bay. Increasing differences in tidal phase and tidal range between the ocean and the back-barrier area eventually result in breaching.
of the spit and formation of a new tidal inlet. By this process large quantities of sand are transferred to the downdrift beaches.

Model 4. Outer channel shifting. This mechanism of inlet sediment bypassing is similar to ebb-tidal delta breaching, but is limited to the seaward end of the main ebb channel and involves smaller volumes of sand. The inner portion of the main channel remains fixed, whereas the outer channel is deflected downdrift because of...