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Storm driven evolution and morphodynamic feedbacks. Sacalin spit, Danube delta

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Deltaic spits are among the most highly dynamic and vulnerable coastal landforms rapidly changing their dimension, plan position and morphology. Sacalin barrier spit formed at the southernmost Danube mouth (Sfântu Gheorghe arm), representing the youngest downdrift feature of the Sfântu Gheorghe deltaic lobe (1500 BP – present). Sacalin emerged in 1897 aided by a major flood and developed by backwards migration and by constant elongation (towards south). Its evolution took place during a strongly anthropogenic influenced period of record high (19th century, beginning of the 20th century) and low solid discharge (late 20th century, beginning of 21 century) which reflects large scale land use and hydrotechnical works in the Danube watershed. With the use of an extensive database consisting in: historical maps, satellite imagery, orthophotos, bathymetric and topographic surveys, LIDAR data, long-term wind speed measurements, long-term wave hindcast data and sediment discharge records, the current study sheds new light on the evolution and behavior of transgressive deltaic islands and spits, and also on the evolution of the downdrift part of the Sfantu Gheorghe lobe by linking morphologic change and climatic variation. The Sacalin cycle appears to be different from past cycles by developing further offshore from the river mouth and by achieving in its last stage of evolution, a flying spit morphology. The high shoreline mobility of the narrow and low Sacalin barrier is mainly driven by coastal storms and associated processes: longshore and cross-shore sediment transport, overtopping, washover fan building and sediment transport during breaching. The barrier spit was frequently breached in the central part and, episodically it experiences large elongation and retreat rates (up to 500 m/year and 80 m/year). The in depth analysis performed on the evolution indices in correspondence with the storm climate and storm-induced sediment transport indicate that the long term evolution is orchestrated by the storm climate and the preexisting barrier island morphology. Moreover, the central sector of the Sacalin spit appears to be controlled by the dynamics and patterns of breaching. The time evolution of the central barrier retreat, which historically has had some of the fastest shoreline retreat rates of over 20 m/yr appears as an intricate patchwork of former and recently deposited breach sands that extend progressively with time into the backbarrier lagoon. Hence, a new 3-stage model of breaching and building up behavior is developed that emphasizes the role of cross-shore sand transport during breaching and morphodynamic feedbacks in the migration and periodically widening of the barrier.