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Multi time-scale morphologic responses of a mid-channel tidal bar to anthropogenic impacts and natural processes: its application to shipping hazard assessment

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Along the macrotidal seaway off the Asan bay mouth, Korea, a large sandy tidal bar located in the channel centre is elongated in form and oriented subparallel to the dominant tidal flow directions. The bar is morphologically about 15 km in length and 2-5 km in width with a relief of 15 m. It is asymmetric in cross section, being gentle sloped along the southwestern side and steeper on the northeastern flank. In the past three decades, serious dredging and deepening activities along the seaway and inside the bay have been conducted particularly for shipping purposes of container ships. Furthermore, along the shores giant dikes were completed in the last decade. The giant mid-channel bar has been inevitably responding morphologically to changing in conditions driven either by natural processes or human activities which break the balance in sediment budgets. Such a morphologic change may pose potential hazards to navigation in a narrow macrotidal channel. In this context, the bar and adjacent sea areas were intensively investigated to understand short- and long-term morphologic response to anthropogenic impacts and natural processes on the one hand. The multi time-scale evolution of the bar is applicable to assess shipping hazards in the area. The grain size trend analysis of surficial sediments and the analysis of bedform asymmetry mapping revealed the dominant sediment transport trends towards the north, which indicate up-slope migration, as is common in other tidal sand ridges. The comparison of decadal time-series bathymetric data extracted from three hydrographic maps showed that the bar expanded along the northeastern flank, whereas in the southwestern side, the bar dramatically shrank. A particular feature is about 500 m north-northeastward migration of the bar in response to changing the total sediment volumes, strongly linked to the active period in sand mining and dredging activities. After a cease in the activities, the sand bar has been rapidly recovered again. The seismic profiles and core facies analyses revealed that the sand bar consist of upper clinoforms with fine sands built up since about 3 ka BP in the wake of a slow rise in local sea level. It overlies a flat bottom made of tidal muds and gravel lags formed during marine transgression. The sand bar is genetically suggestive of tidal ridge origin that has lateral accretion characters. Thus it seems to be migrated north-northeast, not forward as in the case of compound tidal dunes or deltas. Such a sideway migration of the bar may cause potentially serious problem for shipping in the channel.