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Sediment transport pathways on the modern microtidal sand flat along the Kushida River Delta, Ise Bay, central Japan

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Sediment transport pathways on the modern microtidal sand flat along the Kushida River Delta were estimated by a new statistical model proposed herein (P-GSTA method), which is based on the grain-size distribution patterns, and the field observations.

The Kushida River flows into Ise Bay, and forms a bayhead delta. The tidal range of Ise Bay is about 2m during spring tide (microtidal). The sand flat is spread in front of the spit on the right bank of the river, and the width is about 0.4 km2. The sand flat is mainly composed of medium- to coarse-grained sand, and is characterized by sand bars and shallow braided channels. It is interpreted that sediment transport is dominated by fluvial and wave activities.

In the P-GSTA method, a linear function in which six parameters of grain-size distribution (mean, coefficient of variance, skewness, kurtosis, and mud and gravel logratios) are summated with different weighting factors was used to infer sediment transport direction. For automated determination of the weighting factor of each grain-size parameter, the principal component analysis (PCA) of grain-size parameters was conducted. PCA is a technique for explaining the correlation between explanatory variables and automatically organizing them into a few linear synthesis variables with different weights, and the weight of each parameter depends on its variance. It was revealed that the first principal component (PC1) account for the spatial variation of the grain-size distribution as a result of sediment transport. The factor loading of PC1 indicates that the grain-size distribution of sediments on the surface of the microtidal sand flat becomes finer, better sorted, less gravelly, and has a more negatively skewed downcurrent through the sediment-transport processes by fluvial and wave activities. Then, the eigenvector of PC1 was employed as weighting factors of grain-size parameters to calculate linear function of grain size parameters representing sediment transport. The outline of the sediment transport pathways reconstructed by this method is as follows: 1) sediments are mainly supplied from the river mouth, then, 2) they are drifted from northwest to southwest, and finally 3) dispersed northeastward.

Field observation was conducted at August 2008, October 2009, April 2010, October 2010 and January 2011. Sediment transport pathways are estimated based on arrangements of ripplecrest directions and other geomorphological features. Brief summaries of sediment transport patterns inferred by field observation are as described below. 1) At October 2010, it was observed that a large amount of sediment was supplied from the Kushida River into the sand flat by a fluvial flooding, and most of them had been dispersed by waves and tidal currents in April 2010. 2) The cuspate branches from the spit imply the eastward to southeastward local drift of the sediments around this area. 3) The crests of sand bars and ripplecrests on them are arranged roughly northwest-southwest throughout a year, and are almost perpendicular to the wave-incoming directions from northeast. Therefore, the direction of sediment dispersal probably is northeastward.

These two results indicate that P-GSTA method successfully worked on the studied area. More quantitative measurement of sediment transport patterns is required for the accurate evaluation of P-GSTA method in further studies.

Keywords: delta, sediment transport, tide, wave, grain-size distribution