Evaluation of Properties of Bed Phase Transition by the Discriminant Analysis of Experimental and Field Data Sets

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This study provides the quantitative evaluation for modes of the bed-phase transition of bedforms formed by unidirectional flows. Understanding the formative conditions of fluvial bedforms is significant for geological studies, and diagrams showing formative conditions of bedforms have been widely used for analyses of sedimentary structures. However, threshold conditions of bedform formation were not examined quantitatively in previous studies.

In this study, we propose discriminant functions of bedform existence fields in dimensionless parametric space by means of the discriminant analysis using the Mahalanobis distance. We analyzed 3401 existing laboratory and field observation data, and produced new bedform stability diagrams. The discriminant functions of bedform existence fields proposed in this study can be used to evaluate the properties of boundaries between bedform stability fields in terms of error rates of the analysis. Two kinds of the error rates of the discriminant analysis are obtained from (1) ratio of misclassified data and (2) results of cross-validation (the leave-one-out method). For example, as a result of the discriminant analysis, it was indicated that the apparent error rates differ depending on the bedform regimes. The apparent error rates are low at the boundaries between the the lower regime and the transition regime, whereas they are high at the boundaries between the transition regime and the upper regime. The theoretical analysis of Izumi and Parker (2009), which used the weakly non-linear stability analysis of bedforms, might explain the reason why the boundaries between the transition regime and the upper regime are not defined clearly. They predicted that there are hysteresis in the threshold conditions between plane beds and antidunes, and this hysteresis can derive the overlapped region in the laboratory observation data. In this way, our method derives the threshold conditions without any assumptions, providing means for verifying the theoretical examinations.

Reference

Izumi, N., and G. Parker (2009), The bifurcation pattern of the flat bed and antidune transition [in Japanese with English abstract], in *Proceedings of Hydraulic Engineering*, vol. 53, pp. 733–738, Japan Society of Civil Engineers.

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