Understanding river dune splitting through flume experiments and analysis of a dune evolution model

Auteurs: Jord J. Warmink[1], C. Marjolein Dohmen-Janssen[1], Joost Lansink[1, 2], Suleyman Naqshband[1], Olav J.M. van Duin[1], Andries J. Paarlberg[3], Paul Termes[3] and Suzanne J.M.H. Hulscher[1]

[1] Department of Water Engineering and Management, University of Twente, Enschede, The Netherlands
[2] Witteveen + Bos Consultants, Deventer, The Netherlands
[3] HKV Consultants, Lelystad, The Netherlands

Abstract

Forecasts of water level during river floods require accurate predictions of the evolution of river dune dimensions, because the hydraulic roughness of the main channel is largely determined by the bed morphology. River dune dimensions are controlled by processes like merging and splitting of dunes. Particularly the process of dune splitting is still poorly understood and –as a result – not yet included in operational dune evolution models. In the current paper, the process of dune splitting is investigated by carrying out laboratory experiments and by means of a sensitivity analysis using a numerical dune evolution model. In the numerical model, we introduced superimposed TRIAS ripples (i.e. triangular asymmetric stoss side-ripples) on the stoss sides of underlying dunes as soon as these stoss sides exceed a certain critical length. Simulations with the model including dune splitting showed that predictions of equilibrium dune characteristics were significantly improved compared to the model without dune splitting. As dune splitting is implemented in a parameterized way, the computational cost remains low which means that dune evolution can be calculated on the time scale of a flood wave. Subsequently, we used this model to study the mechanism of dune splitting.

Literature showed that the initiation of a strong flow separation zone behind a superimposed bedform is one of the main mechanisms behind dune splitting. The flume experiments indicated that besides its height also the lee side slope of the superimposed bedform is an important factor to determine the strength of the flow separation zone and therefore is an important aspect in dune splitting. The sensitivity analysis of the dune evolution model showed that a minimum stoss side length was required to develop a strong flow separation zone.

Keywords:

Earth Surface Processes and Landforms, ESPL-39, 1208-1220, 2014.

The full article can be requested at the publisher or at HKV consultants (secretariaat@hkv.nl)