Characterising natural bedform morphology and its influence on flow

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Abstract

Bedforms such as dunes and ripples are ubiquitous in rivers and coastal seas, and commonly described as triangular shapes from which height and length are calculated to estimate hydrodynamic and sediment dynamic parameters. Natural bedforms, however, present a far more complicated morphology; the difference between natural bedform shape and the often assumed triangular shape is usually neglected, and how this may affect the flow is unknown. This study investigates the shapes of natural bedforms and how they influence flow and shear stress, based on four datasets extracted from earlier studies on two rivers (the Rio Paraná in Argentina, and the Lower Rhine in The Netherlands). The most commonly occurring morphological elements are a sinusoidal stoss side made of one segment and a lee side made of two segments, a gently sloping upper lee side and a relatively steep (6 to 21^{o}) slip face. A non-hydrostatic numerical model, set up using Delft3D, served to simulate the flow over fixed bedforms with various morphologies derived from the identified morphological elements. Both shear stress and turbulence increase with increasing slip face angle and are only marginally affected by the dimensions and positions of the upper and lower lee side. The average slip face angle determined from the bed profiles is 14^{o}, over which there is nog permanent flow separation. Shear stress and turbulence above natural bedforms are higher than above a flat bed but much lower than over the often assumed 30^{o} lee side angle.