Behaviour of Alternate Bar Patterns in Rivers

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In this paper wavelengths and amplitudes of alternate bars, as predicted by stability analyses, are compared with their measured values. Alternate bars are bed waves in a river, with oblique alternating fronts and wavelengths which scale with the channel width. Alternate bars can be considered as perturbations on the basic state (a flat bed) of a morphodynamic river model (Schielen et al. [3]), which consists of a shallow water flow in a straight channel having a uniform mild slope. The banks are non-erodible, the bed consists of non-cohesive sediment, which is transported as bedload.

A linear stability analysis provides the fastest growing wavelength and the critical wavelength, describing the wave first to become unstable when the width-to-depth ratio increases. According to the linear analysis the wavelengths of alternate bars are close to either the fastest growing or the critical wavelength. A weakly nonlinear stability analysis assumes that the wavelength is close to the critical wavelength. In this case the amplitude of alternate bars can be described by a Ginzburg-Landau equation [3].

The observed alternate bar characteristics are based on experiments (Lanzoni [1],[2]) in a flume (1.5 meter wide, 1 meter deep and 50 meter long). The experiments are carried out in two series with uniform and graded sediment. Several conditions were tested, most of them resulted in alternate bars.

The observed alternate bars are compared with the estimations of the stability analyses. This comparison shows that the measured wavelengths coincide with the critical wavelength even far from critical conditions. Finally the nonlinear estimations of the amplitudes are compared with the measurements.

References

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