# Numerical nonlinear analysis of alternate-bar formation and overdeepening under superresonant conditions

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## 1. Introduction

Local geometrical perturbations in alluvial channels can generate a pattern of alternate bars called ‘overdeepening’. Previous linear analyses and laboratory experiments showed that these bars arise downstream of perturbations in the relatively narrow and deep channels corresponding to subresonant conditions, but both upstream and downstream of perturbations in the relatively wide and shallow channels corresponding to superresonant conditions. Previous numerical computations reproduced alternate bars under subresonant conditions, but failed to do so under superresonant conditions until the recent 2D depth-averaged computations by van der Meer et al. (2011) using Delft3D. They managed to simulate bar formation under superresonant conditions, but observed discrepancies between the numerical results and theoretical and experimental findings.

## 2. Approach

We extended the modelling work of van der Meer et al. (2011) to assess the agreement of numerical results with linear theory and experimental observations, by simulating more cases and by analyzing in detail the causes of the discrepancies.

## 3. Results

The numerical model predicted a higher resonant width-to-depth ratio, $\beta_{res}$, than linear theory. We find that this can be explained by the high horizontal eddy viscosity that had been increased to stabilize the simulations. The numerical model also appeared to overpredict the bar length for large width-to-depth ratios and significantly underpredict the bar length for very shallow simulations. We find that this can be explained by numerical diffusion, introduced by the bed level updating procedure. The numerical diffusion affects the bar pattern spectrum and the length of the most unstable bar. This diffusive effect will not occur when the less stable ‘central’ scheme for the bed level updating procedure is applied.

## 4. Conclusions

We conclude that a 2D depth-averaged numerical morphodynamic model is able to reproduce alternate-bar patterns. The computations provide insight in the way alternate-bar patterns develop. Due attention must be paid to the appropriate selection of horizontal eddy viscosity, numerical scheme for the bed level updating procedure and grid resolution.

## References

Van Der Meer, C., Mosselman, E., Sloff, K., Jager, B., Zolezzi, G. and Tubino, M. (2011). Numerical simulations of upstream and downstream overdeepening. *River, Coastal and Estuarine Morphodynamics: RCEM 2011*, pages 1721-1729 Tsinghua, China