Morphodynamic Equilibria in Double-Inlet Systems

Schuttelaars, H.M.; Deng, X.; De Mulder, T.

Publication date
2023

Document Version
Final published version

Citation (APA)
Schuttelaars, H. M., Deng, X., & De Mulder, T. (2023). *Morphodynamic Equilibria in Double-Inlet Systems*. Abstract from 13th Symposium on River, Coastal and Estuarine Morphodynamics, Urbana-Champaign, Illinois, United States.

Morphodynamic Equilibria in Double-Inlet Systems

H.M. Schuttelaars[1], X.Deng[1,2] and T. De Mulder[3]

[1] Delft Institute of Applied Mathematics, Delft University of Technology, Delft, The Netherlands. h.m.schuttelaars@tudelft.nl

[2] Now at Zhejiang Lab, Hangzhou, Zhejiang, China. dengxiaosp@163.com

3 Hydraulics Laboratory, Civil Engineering, Faculty of Engineering and Architecture, Ghent University, Ghent, Belgium. tomfo.demulder@ugent.be

1. Introduction

Tidal basins are connected to the outer sea by one or more tidal inlets. In this presentation, we focus on so-called double inlet systems, i.e., tidal inlet systems with two connecting channels. A typical example is the Marsdiep-Vlie system, located in the Dutch Wadden Sea. Using an idealized morphodynamic model, we aim at directly finding morphodynamic equilibria of double inlet systems and assess their stability. For unstable configurations, the linear stability mechanism will be presented.

2. Methods

The depth-averaged shallow water equations, suspended sediment transport equation and bed evolution equation are used to model the morphodynamics of the double inlet system. This system of equations is analyzed using an asymptotic analysis in a small parameter, the ratio of the tidal amplitude of the undisturbed water depth. Since the water motion and sediment transport take place on a much shorter timescale than the bed evolution, the bed is considered fixed on the fast hydrodynamic timescale and the bed profile only changes on the long timescale. After discretizing the model equations using the finite elements method, morphodynamic equilibria are found using a continuation method: this is a method to directly obtain solutions of the equations sought for such that the tidally averaged sediment transport is constant in the tidal inlet system.

3. Results

To study the number and stability of morphodynamic equilibria, we will focus on a rectangular double inlet system with a length of 30 km. The system is only forced by an M_2 tidal constituent at both connections to the sea. For the system under consideration, it turns out that the sediment is mainly transported in suspension by diffusive processes. In this presentation, we will systematically investigate the sensitivity of the underlying morphodynamic equilibria, both their number and stability, for different drag coefficients and embayment widths. The associated equilibrium bed profiles and underlying mechanisms will be discussed in detail.

In Fig.1, an example is shown of a so-called bifurcation diagram, with the drag coefficient on the horizontal axis and a measure of the equilibrium bed profile on the vertical axis. In this diagram, the stable equilibria are shown as solid lines, while the other lines indicate unstable equilibria. In Fig.2 the associated equilibrium bed profiles are shown

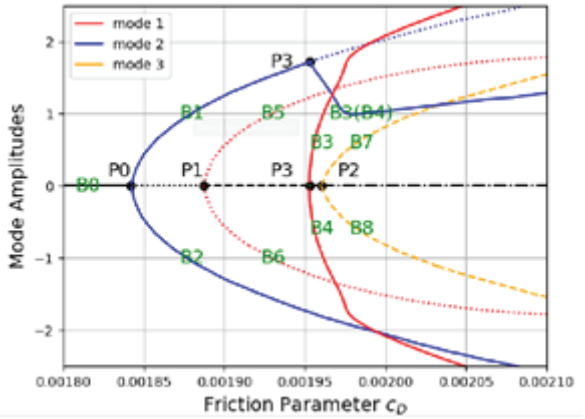

Figure 1, Bifurcation diagram, indicating the various morphodynamic equilibria and their stability as a function of the bed firction parameter.

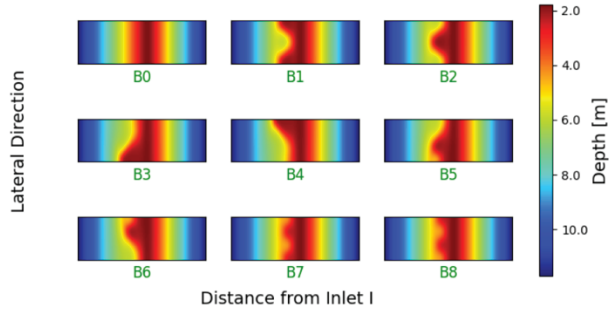

Figure 2, Equilibrium bed profiles associated with the bifurcation diagram shown in Fig.1.

4. Conclusions

Instead of using a time-integration method, a continuation method that directly searches for morphodynamic equilibria is a fast method to get insight in their number and stability for varying parameters. Furthermore, this approach allows for a systematic way to investigate the physical mechanisms resulting in such equilibria.

References

Deng, X. (2023). Morphodynamic equilibria in double–inlet systems, their existence, multiplicity and stability. PhD Thesis, TU Delft, The Netherlands. https://doi.org/10.4233/uuid:afad2560-3e7b-4b43-9997-17b4e24e9e02