SIMPLIFIED TREATMENT OF THE FLOW AND THE USE OF A MORPHODYNAMIC FACTOR IN LONG-TERM MORPHODYNAMIC COMPUTATIONS

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A complicating factor in long term morphodynamic computations is the presence of multiple time scales for the propagation of disturbances in the water surface elevation (fast) and bed elevation changes (slow). The general consequence for a numerical model is a combination of a long simulation time with a small time step to capture all the effects to a particular disturbance. For a large scale computation in a two dimensional domain, however, the computational effort becomes too large, and artificial 'tricks' become necessary. Common techniques are a simplified treatment of the flow that eliminates the small scale effects, such as the steady state backwater curve or normal flow approximation, or the use of a morphodynamic acceleration factor. In the latter, the computed sediment transport rate is multiplied by the morphodynamic factor such that the resulting bed elevation change represents the change that occurs during a larger time step. In other words, the morphodynamic change is accelerated and the total simulation time is divided by the morphodynamic factor. Here we study the impact of these techniques on long-term morphodynamic runs. Numerical simulations have been performed to assess these effects and make a comparison between the techniques. Figure 1 shows an example in which we study the response of the river bed to a yearly cycled hydrograph with one yearly peak for (1) an unsteady treatment of the flow (i.e. the Saint-Venant equations), (2) a steady state treatment of the flow (i.e. a backwater curve), and (3) an unsteady treatment of the flow accelerated by various values of the morphodynamic factor (10, 20, 40, 80). The runs start from a constant bed slope and normal flow conditions. At the upstream end, the equilibrium sediment transport rate and the yearly cycled hydrograph are prescribed, and at the downstream end the water surface elevation is fixed at the initial normal flow depth of the dominant water discharge. This results in an M1-backwater effect during base flow, and an M2-backwater effect during peak flow, the effect of which on the bed elevation, balance each other (i.e. in a dynamic equilibrium). Figure 1 shows the situation after 100 years. While the output of the steady simulation resembles the unsteady simulation quite well, the simulation result with the morphodynamic acceleration factor reduces with increasing morphodynamic factor. This can be explained by the damping of the peak discharge before it reaches the downstream end of the domain, such that there are M1 curves during both base and peak flow.

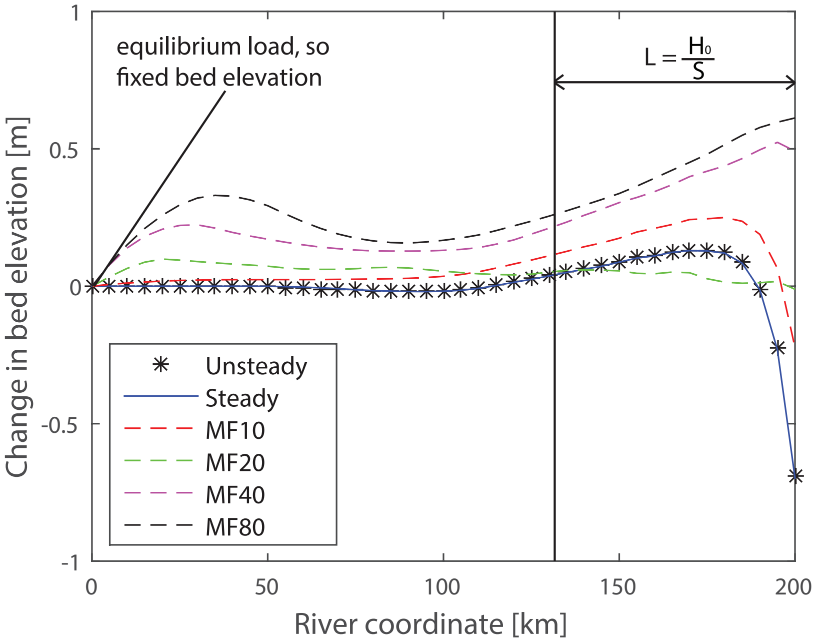

Figure 1. Change in bed elevation (relative to the initial state) after a 100 year run, under a cyclic (1 year period) hydrograph. L indicates a characteristic backwater length, H_0 is a characteristic flow depth, and S is the channel bed slope.