

## Sorting waves and associated eigenvalues

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The presence of mixed sediment always characterizes gravel bed rivers. Sorting processes take place during bed load transport of heterogeneous sediment mixtures. The two main elements necessary to the occurrence of sorting are the heterogeneous character of sediments and the presence of an active sediment transport. When these two key ingredients are simultaneously present, the segregation of bed material is consistently detected both in the field [7] and in laboratory [3] observations.

In heterogeneous sediment transport, bed altimetric variations and sorting always coexist and both mechanisms are independently capable of driving the formation of morphological patterns. Indeed, consistent patterns of longitudinal and transverse sorting are identified almost ubiquitously. In some cases, such as bar formation [2] and channel bends [5], sorting acts as a stabilizing effect and therefore the dominant mechanism driving pattern formation is associated with bed altimetric variations. In other cases, such as longitudinal streaks, sorting enhances system instability and can therefore be considered the prevailing mechanism. Bedload sheets, first observed by Kuhnle and Southard [1], represent another classic example of a morphological pattern essentially triggered by sorting, as theoretical [4] and experimental [3] results suggested. These sorting waves cause strong spatial and temporal fluctuations of bedload transport rate typical observed in gravel bed rivers.

The problem of bed load transport of a sediment mixture is formulated in the framework of a 1D linear stability analysis. The base state consists of a uniform flow in an infinitely wide channel with active bed load transport. The behaviour of the eigenvalues associated with fluid motion, bed evolution and sorting processes in the space of the significant flow and sediment parameters is analysed. A comparison is attempted with the results of the theoretical analysis of Seminara Colombini and Parker [4] and Stecca, Siviglia and Blom [6].

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