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Where Small is Beautiful - mathematical modelling and free surface flows

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ABSTRACT

In river and canal hydraulics often complicated methods have been used instead of simple ones. Here, some lesser-known mathematical techniques are presented that can help in the application of simpler methods, including linearized methods and formulae. Then several problems in free surface flows are examined through a filter of simplicity, and several results obtained. Some of the methods described will be known to some people, but not all to all. Simple finite difference methods for the long wave equations are presented. They have long been incorrectly believed to be unstable. The apparently trivial problem of providing boundary conditions has traditionally been neglected; a discussion and several results are given. Muskingum routing is severely criticised. The numerical solution of the steady gradually-varied flow equation is discussed and simple methods are proposed and demonstrated. A general linearised model for the surface profile of a river is obtained where there is insufficient data for detailed computations. Finally the use of optimisation and systems methods are demonstrated for problems where there is little data other than flow records.