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APPROXIMATE MODELS FOR MUD FLOOD PREDICTION

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Unsteady shallow-layer flows may be described through full dynamic models or using simplified momentum equations, based on kinematic, diffusion and quasi-steady approximations, known as approximate dynamic wave models. The knowledge acquired in the field of clear-water flood routing has demonstrated that the full dynamic wave models may be substituted by the approximate wave models only under appropriate circumstances. Similarly to the clear-water case, simplified routing models may represent an advantageous alternative to the numerical solution of the full dynamic equations for the prediction of mud flood propagation. However, no criteria have been provided in order to define the applicability range of these simplified models for mud flow. The aim of the presented study is to investigate through linear analysis the applicability range of simplified shallow-wave models with special concern to unsteady flows of muds. Considering a three-equations depth-integrated Herschel-Bulkley model, the applicability of the approximated models is discussed comparing the propagation characteristics of a small perturbation of an initial steady uniform flow as predicted by the simplified models with those of the full dynamic model. Based on this comparison, applicability criteria expressed as lower bounds for the dimensionless wave period, , are derived. It is worth of note that, based on the knowledge the threshold values, the corresponding dimensional wave period may be evaluated and compared with the time-to-peak of the inflow hydrograph..The performed analysis suggests that the criteria developed for water flows in turbulent condition cannot be straightforwardly applied to mud flows, since fluid rheology, influencing the propagation characteristics, significantly affects the lower bound of the dimensionless wave period required for the applicability of the different approximations. The obtained simple maps may be useful for engineering predictions.