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Dam break - outburst flood propagation, transient hydraulics and geomorphic work

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Dam break outburst floods are sudden, short-lived and high-magnitude discharges of water and sediment propagating over an initially ‘dry’ terrain. Both field observations by geoscientists and experimental measurements by engineers have produced understanding of outburst floods but neither approach has satisfactorily supplied data that is directly of use to hazard managers. This study draws together those two literature groups and provides new experimental data to test hypotheses concerning the effect of a series of external controls on resultant longitudinal flow propagation, transitory hydraulics and geomorphic work. These external controls form experimental treatments and are; i) the height of the lock gate raise as a surrogate for dam breach evolution and initial hydrograph, ii) bed roughness, iii) suspended sediment concentration, and bed mobility. These control both horizontal and vertical fluid motion, the latter of which is a key property for controlling aeration, bed shear stress and turbulence intensity. The experimental treatments show that outburst floods on horizontal beds can be identified to possess three longitudinal flow regimes. Firstly, there is a short acceleration due to the reservoir pressure level; i.e. the depth of impounded water. Secondly, channel flow quickly converges to an inertial regime. The third flow regime is viscous and dominated by channel bed friction. Bed mobility dramatically increases bed friction. Flow depth increases in the inertial regime, then decreases in the viscous regime. Experiments herein show that the timing of the peaks at-a-point down channel of each hydraulic quantity varies; most notably peak bed shear stress precedes flow velocity, which precedes peak flow depth. A point of inflexion occurs with distance down channel that is a manifestation of the transition from accelerating to decelerating flows. These external controls, and the effects of them on longitudinal and vertical motion are analysed quantitatively and related to both erosion and deposition patterns and volumes. These experiments should serve as a platform for future probabilistic and process-based modelling of outburst floods.