Approximated analytical solutions of shallow-water equations for particle-driven gravity currents propagating in channels of power-law cross-sections

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Particle-driven gravity currents are suspensions of dense particles that spread into an ambient fluid due to the difference between the density of the suspension and that of the ambient fluid. During the evolution of the current, particles continually sediment and are deposited from the flow. Particle-driven gravity currents are important in many environmental situations, including volcanic ash flows and turbidity currents. We use the shallow-water PDEs with the corresponding boundary and initial conditions to model the main characteristics of the current during its propagation. Usually, the problem is solved numerically by a finite-difference method. However, in some special circumstances it has analytical solutions. In the present work we discuss such cases. In particular, we show that asymptotic analysis developed here permits a number of valuable characteristics of the similarity solutions for homogeneous gravity currents to be carried over to particle-driven currents. The simplified box-model approach is also used to provide useful analytical expressions. In particular, it is possible to derive simple relationships for the temporal evolution of the current length. The analytical solutions are compared with the numerical solutions.

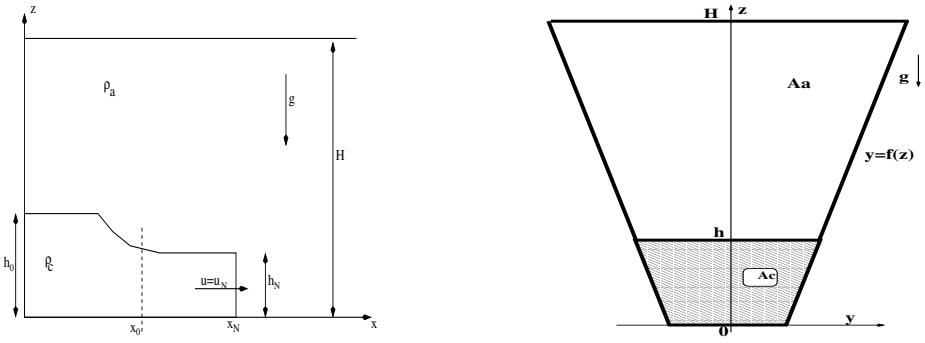

Figure 1: (a) Schematic description (side view) of the current released from a lock of length x_0 and height h_0 in the channel of height H with non-rectangular cross-section. (b) Typical cross-section of channel.

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References

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