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Quasi-steady State in Experimentally Produced Turbidity Current Under a Large Amount of Suspension Supply

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Abstract

Turbidity current is generated in an inclined lock-gate flume under a large amount of suspension supply. By opening the gate, turbidity current generates and flows to downstream. The turbidity current maintains its interface structure and progresses with constant frontal velocity. The inner velocity profile of the quasi-steady body by ultrasound velocity profiler (UVP) falls on the similar convex lines within the fluctuations in space and time. We conclude that turbidity current progresses in a steady state flow structure with small dissipation, which is a key to transport a large amount of sediment in a long distance.

1. Research Questions

In the turbidity current,

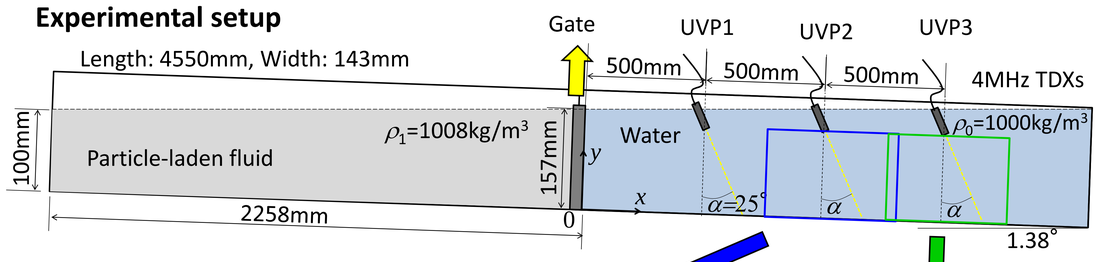
Q1. Shape of flow?

Q2. Spatio-temporal development by UVP measurement?

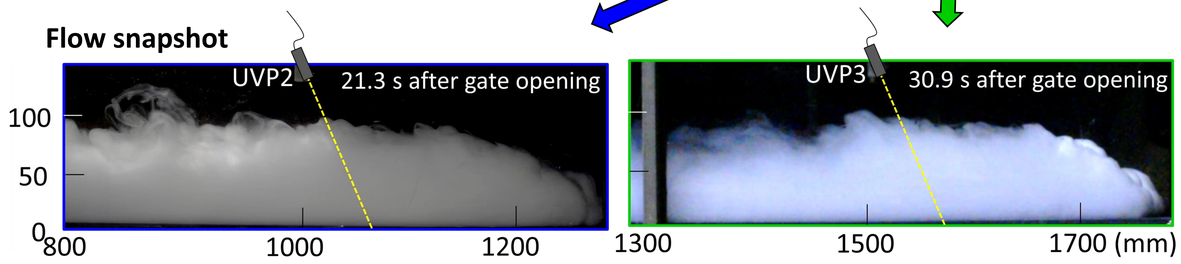
Q3. Steady progress structure?

2. Methods & materials

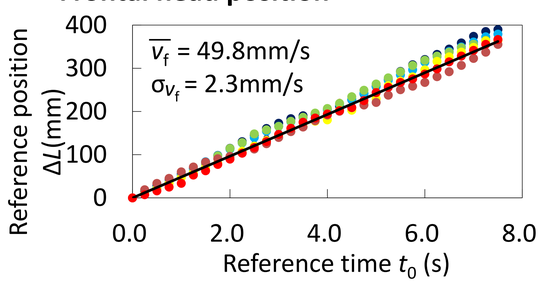
Experimental setup



Flow snapshot

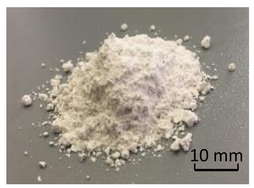


Frontal head position



Sediment material

Quartz flour

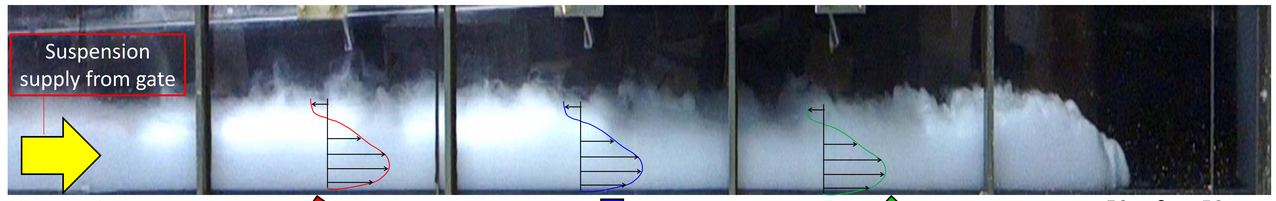


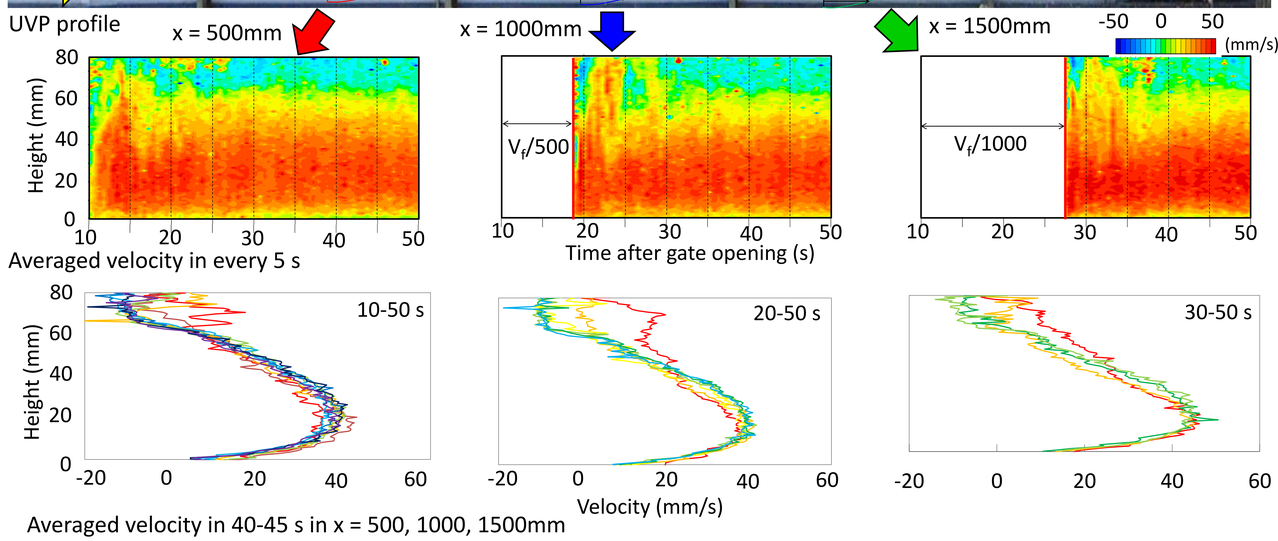
ρ_s= 2.65g/cm^3

D_{50}= 2.6μm

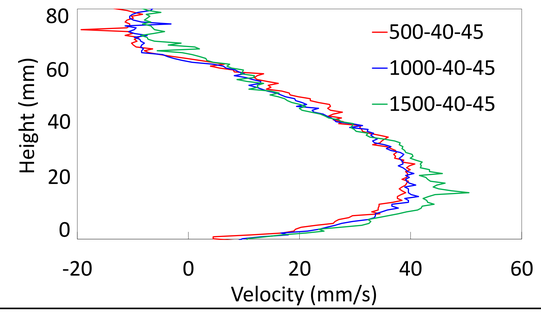
v_s= 0.14mm/s

3. Velocity measurement result





Averaged velocity in 40-45 s in x = 500, 1000, 1500mm



In the body of turbidity current,

- ✓ Averaged velocity distribution shows similar convex distribution regardless of time and space.
- ✓ No acceleration or deceleration generate.
- ✓ No mixing and entrainment with ambient water.
- ✓ Sediment transport takes place in constant rate.

4. Research Answers

Answer for Q1. Head intrudes to ambient water showing the curved interface. Body progresses representing horizontal interface with small fluctuation behind the head.

Answer for Q2. After the unsteady head, body migrates without entrainment or detrainment of ambient water as steady state.

Answer for Q3. The averaged velocity distributions fall on the similar convex line with the fluctuations.

5. References

- Nomura et al., GraCE: Velocity Structure and Spatio-temporal Evolution in the Turbidity Current Head based on Ultrasound Doppler Velocity Profiler, EGU General Assembly, 2017
- Nomura et al., Sediment mass movement of a particle-laden turbidity current based on ultrasound velocity profiling and the distribution of sediment concentration, Geological Society, London, Special Publications, 477, 2018
- Nomura et al., Instantaneous Flow Vector Measurement by a Pair of Ultrasound Doppler Instruments, Proc. of the 11th International Symposium on Ultrasonic Doppler Methods for Fluid Mechanics and Fluid Engineering 11th ISUD, September 5-7, (2018b), Berlin, Germany, 119-122
- Nomura et al., Quasi stationary flow structure in turbidity current, International Journal of Sedimentation Research (in prep.)

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