Geophysical Research Abstracts
Vol. 19, EGU2017-3645, 2017
EGU General Assembly 2017

Application of an MPS-based model to the entrainment and deposition process of debris flows

Takuro Suzuki (1), Norifumi Hotta (2), and Haruka Tsunetaka (2)

(1) Forestry and Forest Products Research Institute, Tsukuba, Ibaraki, Japan (takurosuzuki@ffpri.affrc.go.jp), (2) Faculty of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki, Japan

The use of a modified moving-particles simulation model (MPS-DF) to simulate the inundation and sediment deposition of debris flows is presented in this paper. This model is based on the moving-particles semi-implicit (MPS) method, which was originally used for incompressible viscous fluid flows with free surfaces. In the MPS-DF model, the constitutive equations of Egashira et al. (1997) are introduced to the MPS method. In Egashira's theory, debris flows are treated as a continuum; therefore, each particle has a variable sediment concentration value. In the MPS-DF model, sediment concentration values spread among the neighbouring particles in order to reduce the difference between the equilibrated vertical distribution of the sediment concentration and actual distribution. With the MPS-DF model, when the particles move to a region with a lower gradient, the sediment concentration moves closer to the riverbed particles, and the riverbed particles stop. This is because the Coulomb friction term in Egashira's formula exceeds the shear force when there is a high sediment concentration and a low inclination. This event corresponds to the deposition process. In this study, we tested the applicability of the MPS-DF model for the formation process of alluvial fans by conducting a flume experiment. The experimental flume consisted of a 6.0 m long and 0.1 m wide straight channel, with an inclination of 15 °, connected to an outflow plain. The inclination of the outflow plain decreased gradually from 12 to 3 °. A 5.0 m long erodible bed, with a thickness of 0.2 m, was present along the straight channel. Water was supplied from the upper end of the flume for 60 s at the rate of 2,000 m^3/s and a debris flow was generated by entraining the erodible bed. The debris flow inundated and deposited sediment at the outflow plain and an alluvial fan formed. Numerical simulations were also performed using the MPS-DF, as well as a depth-integrated method based on the shallow water equations (2D Simulation). The 2D Simulation results of the alluvial fan shape and flooding area were spread out laterally and differed significantly from those of the experiment. The results of the MPS-DF were more similar to the experimental results, as natural channels and lateral levees were formed; however, the shape of the alluvial fan produced by the MPS-DF was slightly wider than that of the experiment. This is thought to be due to the behaviour of the pore water. Therefore improvement to the calculation method for unsaturated seepage flow in future work may be beneficial.