Utrecht University

DFHM8
July 2023

Effects of debris-flow and bed composition on erosion and entrainment

Lonneke Roelofs, Pauline Colucci, Eise Nota, Tom Flipsen & Tjalling de Haas
l.roelofs@uu.nl

Introduction & method

Erosion and entrainment of material by debris flows (DF) determine debris-flow volume growth and therefore hazard potential. **Impact and shear forces**, as well as **pore pressures**, have been recognized as important parameters for erosion. However, how erosion magnitude and these factors depend on the composition of the debris flow and the composition of the bed remains unclear.

By performing experiments in a small-scale flume (Fig 1) with a loosely packed erodible bed we determined the effects of **debris-flow and bed composition** on debris-flow erosion processes and magnitude. We quantify the effects of the **gravel**, **clay**, and **water** content in the debris flow and in the erodible surface on bed erosion by debris flows.

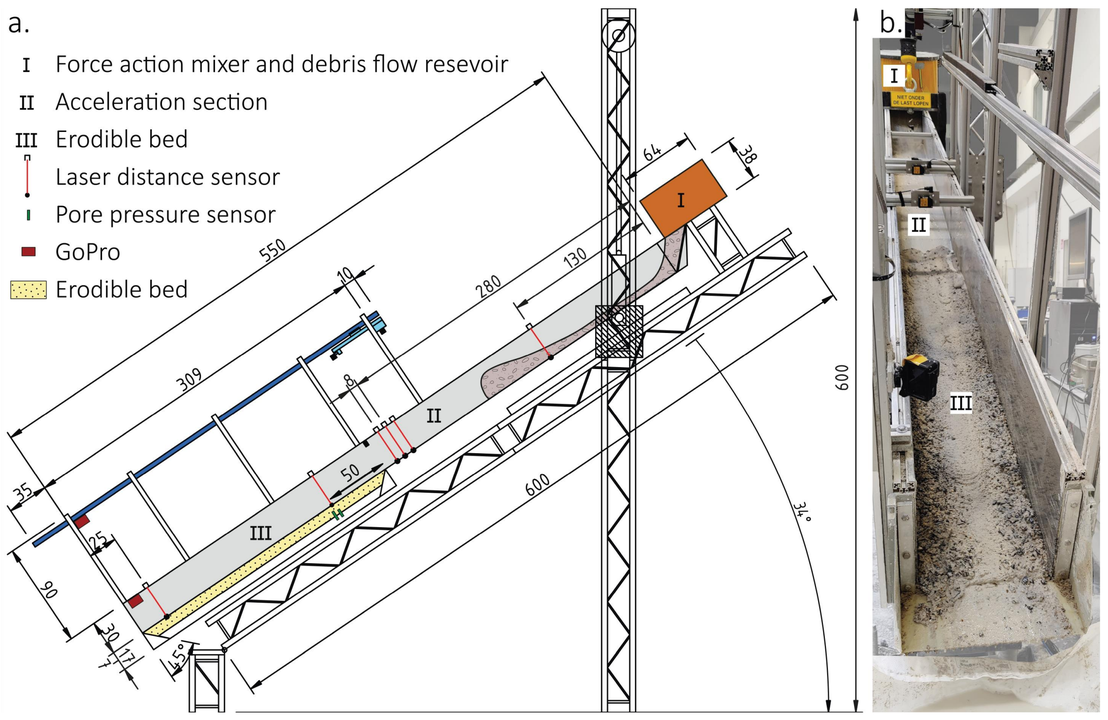
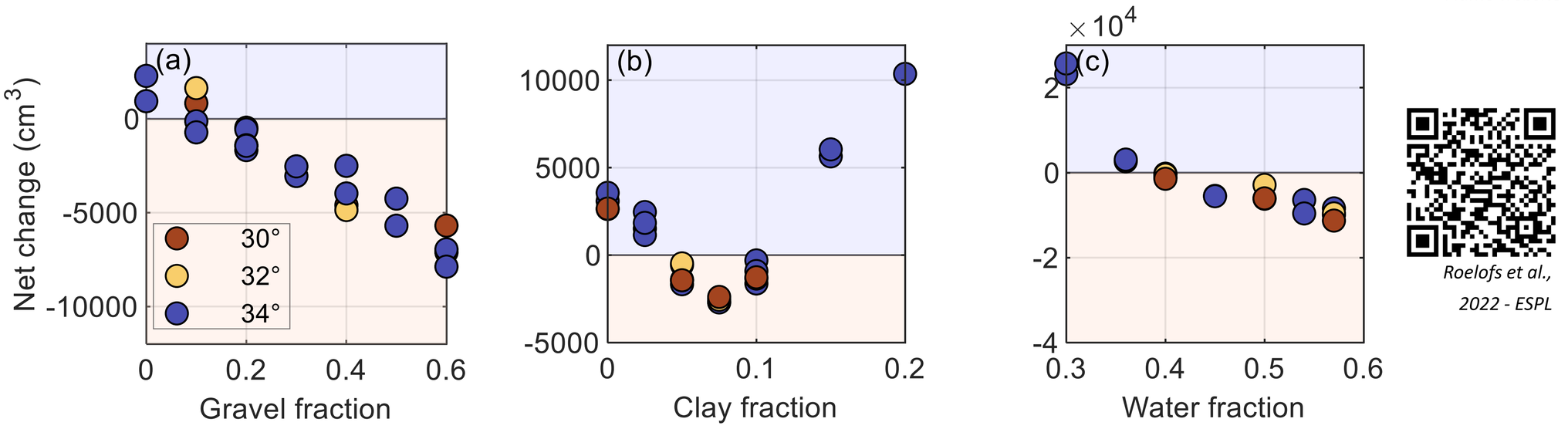


Fig 1 *Flume set-up. The yellow cylinder is the sediment-mixing tank. In the lower half of the flume the erodible bed is present. When varying DF composition, the bed composition was kept constant. When bed composition was varied DF composition was kept constant.*

Flume website

Results

Debris flow

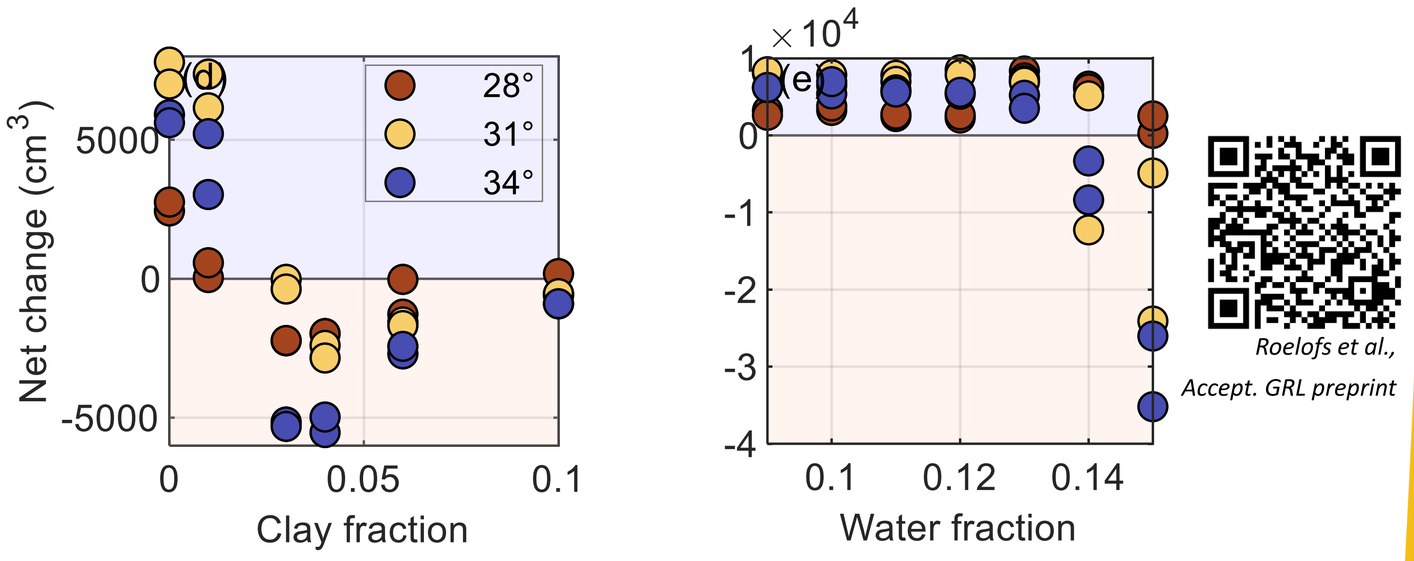


Roelofs et al., 2022 - ESPL

Increasing **gravel fraction** of the DF linearly increases erosion related to an **increase in impact and shear** forces (Fig 2a-c).

An increase in **clay and water fraction** of the DF or the bed results in a non-linear erosion response related to combined effects of **viscosity and pore pressures** (Fig 2d-e).

Bed



Roelofs et al., Accept. GRL preprint

Fig 2 *Net change of the erodible bed for two sets of experiments. Panels (a)-(c) depict the results of experiments with varying DF compositions. Panels (d) and (e) depict the results of experiments with varying bed compositions.*

Discussion & conclusions

Debris flow

For different DF compositions, the influence on erosion is caused by the combined effects of the magnitude of the **impact and shear forces** on the bed and the effectiveness of **pore pressure** transfer to the bed (Fig 3).

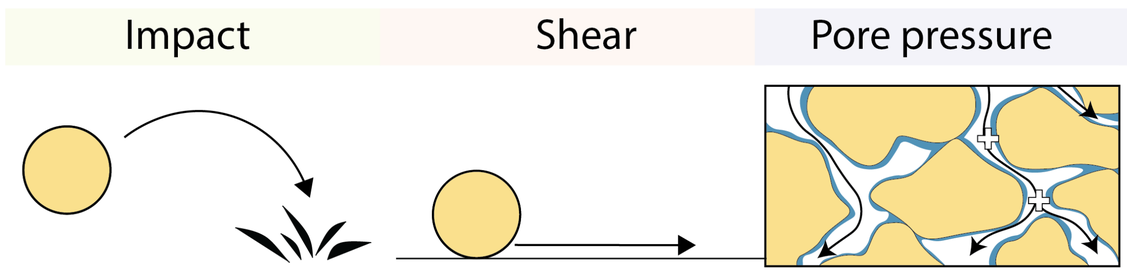


Fig 3 *Main erosion aiding forces. Impact and shear forces increase linearly as a result of increasing gravel content in the debris flow. The response of these forces to an increasing clay and/or water content of the debris flow is non-linear due to the complex influence of composition on DF dynamics, impact and shear forces, and pore pressures.*

Bed

Bed composition influences erosion by DFs by affecting the transfer of **pore pressure** through the bed, **loading conditions,** and **dilative/contractive** behaviour (Fig 4 for increasing bed clay content).

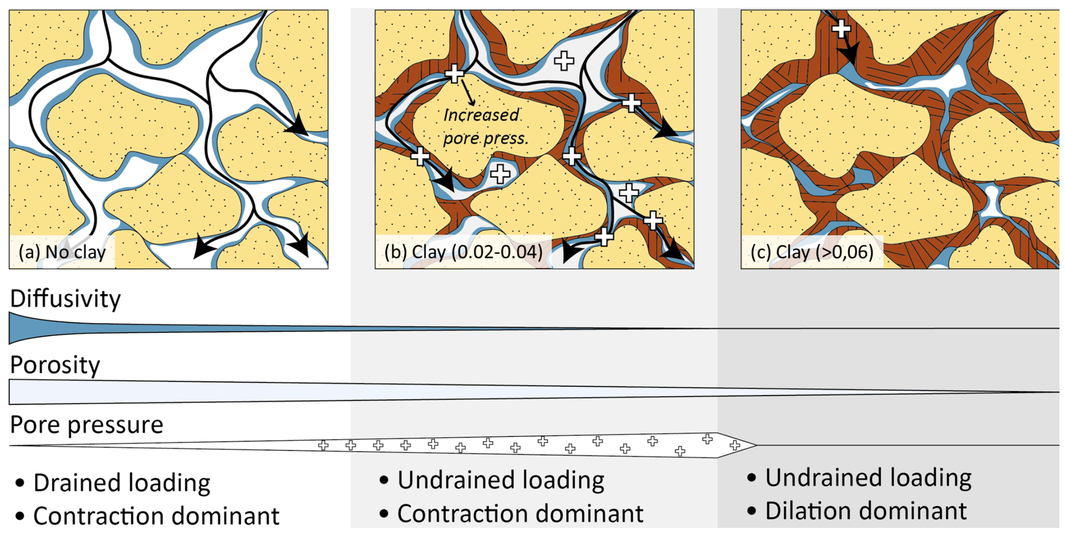


Fig 4 *The effect of bed clay content on erosion by debris flows. It is hypothesized that increasing water content, on top of increasing clay, will aid the processes depicted.*