Simulating heavy rain events for parameterizing a first application of the physically based soil erosion model EROSION3D in South Africa

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Fig. 1: Overlay of model results and aerial image of the research catchment Phama near Ladybrand

Introduction to EROSION 3D

- developed to forecast and simulate **soil detachment, transport** and **deposition** as well as **surface runoff**
- **Event-based** depiction of erosion processes
- Simulation of **conservation measures** (e.g. buffer strips, retention ponds, grassed waterways, no-till…)
- Reconstruction of **hydrographs** and thus **flood peaks**
- **precise localisation** of erosion hot spots, flow paths and potential conflicts with infrastructure

Fig. 2: Highly degraded land surface at the Phama research site close to Ladybrand, Free State

Fig. 3:Detailed orthophoto of permanent erosion control measures south of Marseilles, Free State

EROSION 3D

Parameter input

Parameter	Source
Initial moisture	→ Stationary sensors and SAR Sentinel-1
Elevation model	→ UAV, DMC/CD-NGI and TanDEM-X
Soil data	→ Sampling and digital soil mapping
Erosivity, roughness and infiltration	→ Rainfall simulations
Rainfall	→ Weather stations and climate modelling

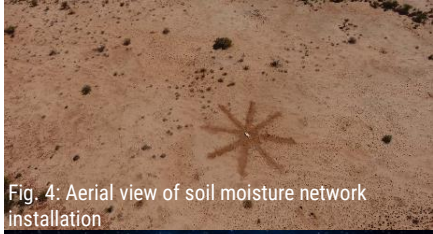


Fig. 4: Aerial view of soil moisture network installation

Fig. 5: Illustration of the TanDEM-X satellites
Image courtesy: esa

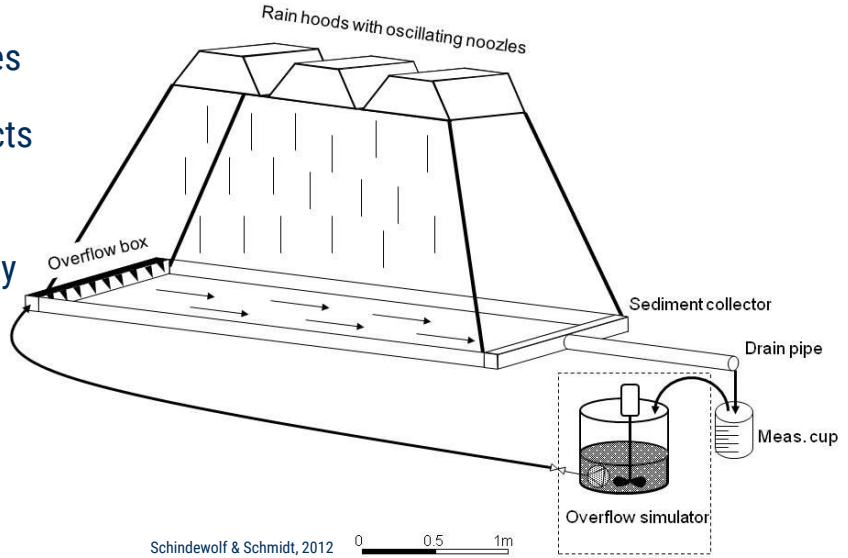
Fig. 6: Rainfall simulator setup at Vinies Farm close to Ladybrand

Rainfall simulations

Fig. 7: Rainfall simulator setup at Phama near Ladybrand

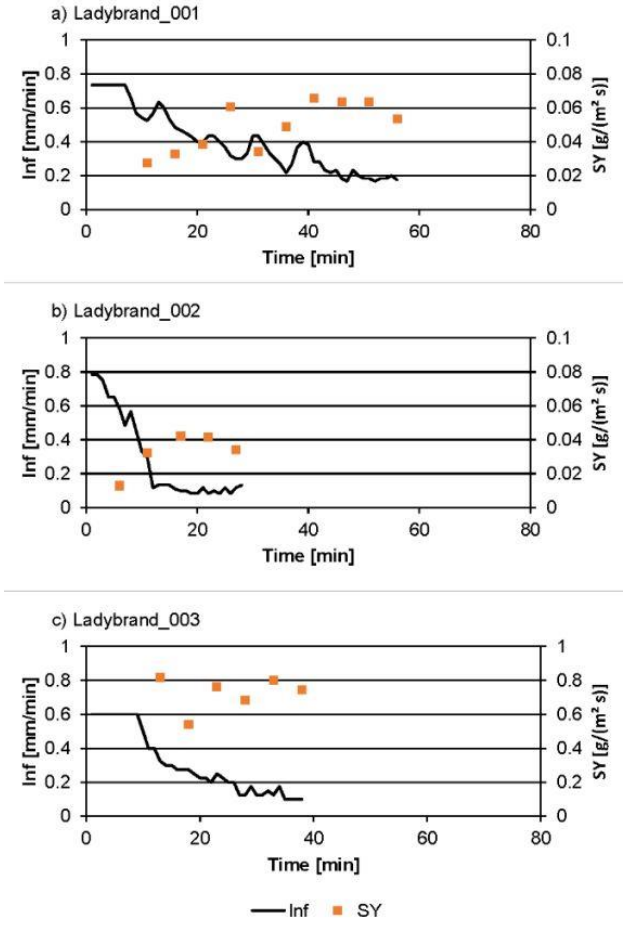
Fig. 8: Core sampling at the Phama test site

- Intensity set to 40 mm/h
- 3 x 1 m² plot size
- Three oscillating flat-jet nozzles
- Overflow tool to simulate effects of sheet flow on longer slopes
- Grain size analysis, bulk density and SOC in laboratory analysis in progress



Results of experiments

- Inf = infiltration, SY = sediment yield
- Duration of experiment is dependent on the occurance of steady-state infiltration rates
- Locations of simulations:
  a) grass land / degraded pasture
  b) Exposed clay rich sub soil (duplex)
  c) Gully side wall (mind different scale for sediment yield!)



EROSION 3D

Input parameters for model run

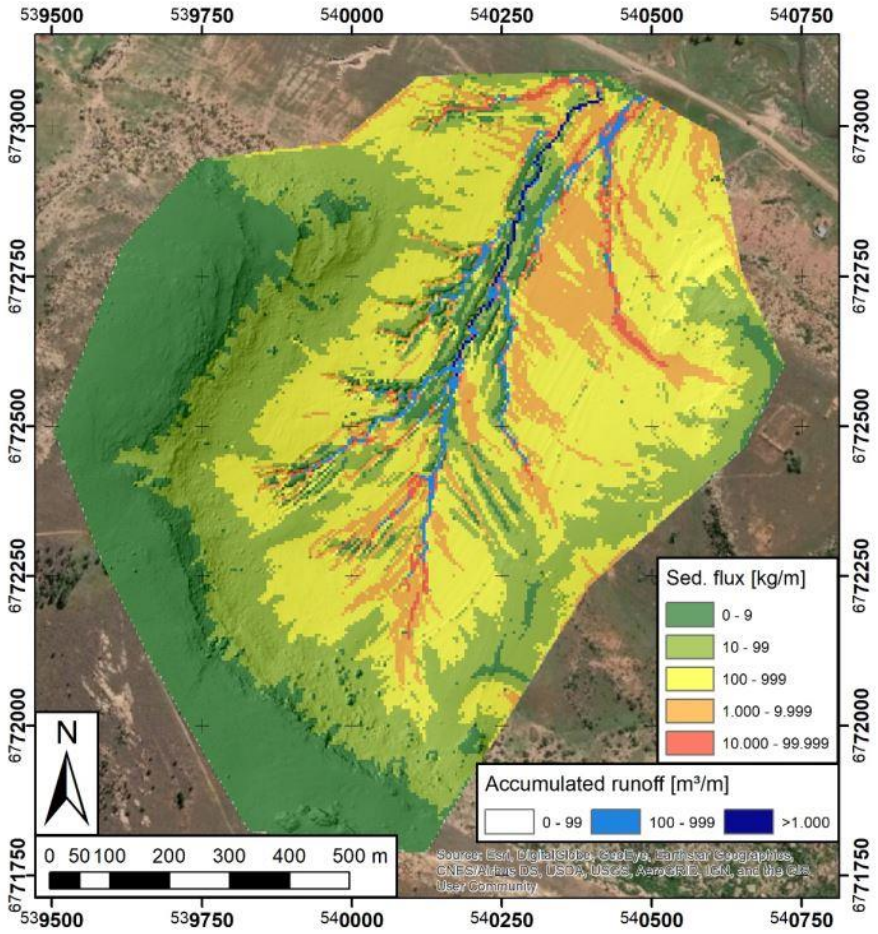
DEM:	5m raster resolution
Rainfall:	13mm/30min, 10min temporal resolution
Bulk density:	1.31-1.59 g/cm³
SOC:	0.8-1.2 vol%
Texture:	sandy loam on the slopes and grass land, clay in the exposed subsoils and gullied areas
Roughness:	0.045-0.105 $s/m^{1/3}$

Lessons learned – currently open questions:

Compared to rainfall simulation results the modelling results seem to produce too high sediment rates.

Possible drivers for overestimation of SY and q

- → Resolution of DEM
- → Grain size composition of soils
- → Flow width in gully system only pixel wide
- → Effects of initial soil moisture below permanent wilting point on EROSION3D parameter „skin factor“



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South African SALDi Land Degradation Monitor

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