Modelling Soil Erosion and Sediment Transport on Post Mine Sites

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⇨ removal of overlying burden material leads to formation of extensive spoil-piles with steep slopes
⇨ Impacts have to be rehabilitated into stabile self sustaining eco-systems with no off-site pollution
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Motivation:

⇨ Severe soil losses on fragile, water repellent and non-vegetated soils of post mine sites

⇨ Erosion processes are strongly involved in acidification of surface waters

Long-term renaturation of mine sites needs reliable assessment of soil erosion risks

Objectives:

- ⇨ Development of a model based methodology to determine erosion risks on slopes in recultivation areas
- ⇨ Implementation of special soil characteristics of coal-containing mine sites (e.g. water repellency) in the soil erosion model EROSION 3D

⇨ Applying the EROSION 3D model to plan, dimension and test erosion control measures on post mining landscapes

Computer model

- ⇨ Event and raster-based physical soil erosion model (cellular automata type)
- ⇨ Prediction of runoff and particle detachment, transport and deposition
- ⇨ Infiltration modelling according to GREEN&AMPT (1911) approach
- ⇨ Momentum flux approach by SCHMIDT (1996) describes particle detachment and transport

Model input-parameters:

- Relief data
- Rainfall data
- Soil parameters

  (e.g. bulk density, grain size, calibration factors, etc.)

→

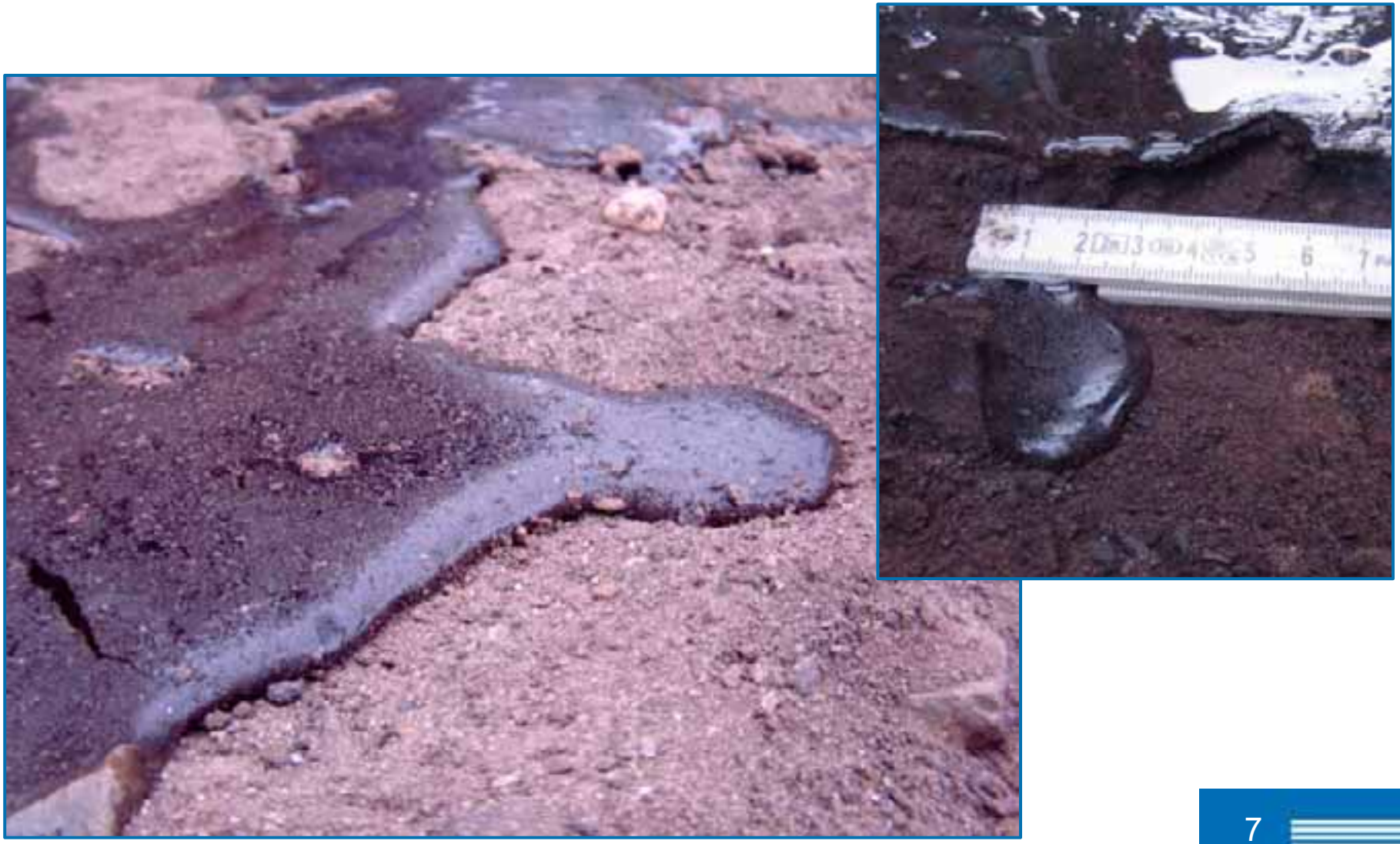
Model output-parameters:

- Spatial parameters
- Cross section parameters

Rainfall simulator:

- Three linked rainfall modules (height: 2 m, plot size: 3x1 m)
- Each with VeeJet Nozzles 80/100
- Runoff and sediment are collected
- Two steps: infiltration and erosion experiment
- Runoff feeding device allows simulation of variable virtual lenght of slope up to 50 m (SCHINDEWOLF, 2012)

Water repellency effects occuring during rainfall experiments on coal containing post mine sites



Rainfall experiments on coal containing post mine sites

Water repellency reduces infiltration to a minimum

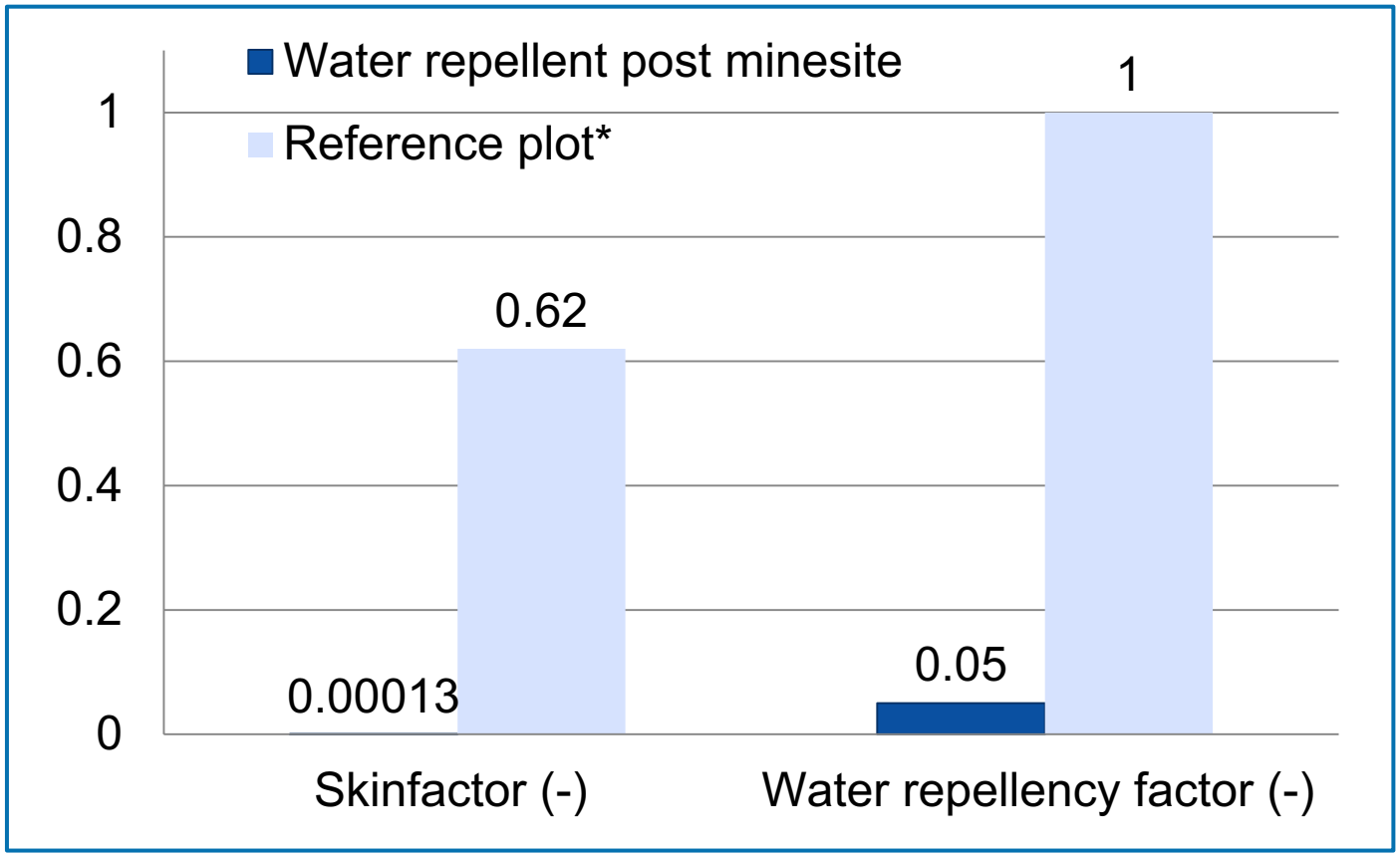
→ Rainfall intensity: 0,6 mm/min

→ Rainfall duration: 1 h

→ Wetting front infiltrates less than 0,5 cm

Rainfall experiments on coal containing post mine sites

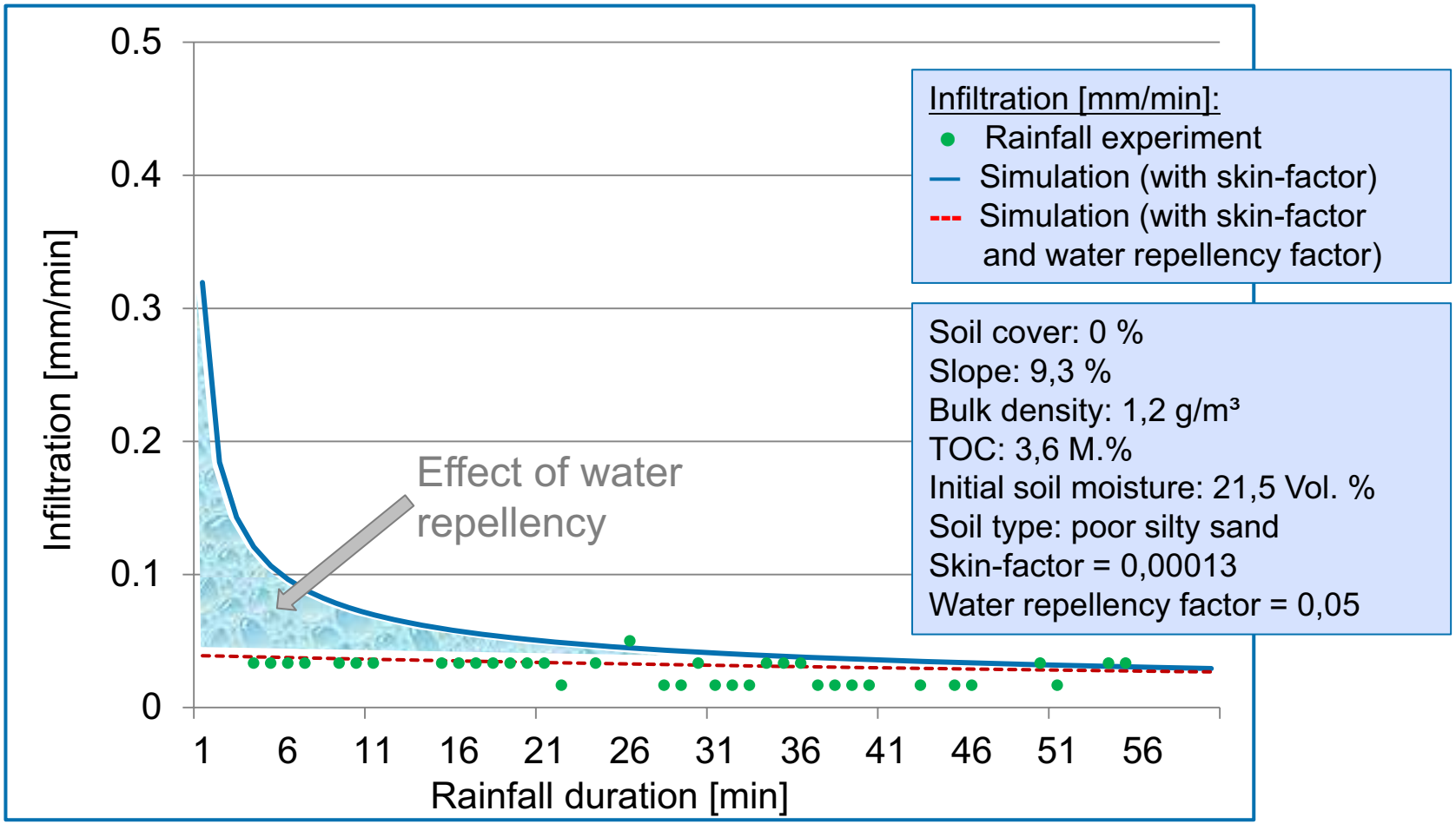
Experimentally determined EROSION 2D/3D calibration factors:



* Data from "Parameter catalogue of Saxony" (Michael, 2000) for dry and sandy ploughed land

Comparison of measured infiltration rate and E2D/3D-simulated infiltration curve

Calibration of calculated infiltration rates by water repellency factor



Rainfall experiment on crusted mine sites

Comparison of infiltration rates and sediment concentrations: with/without soil crust

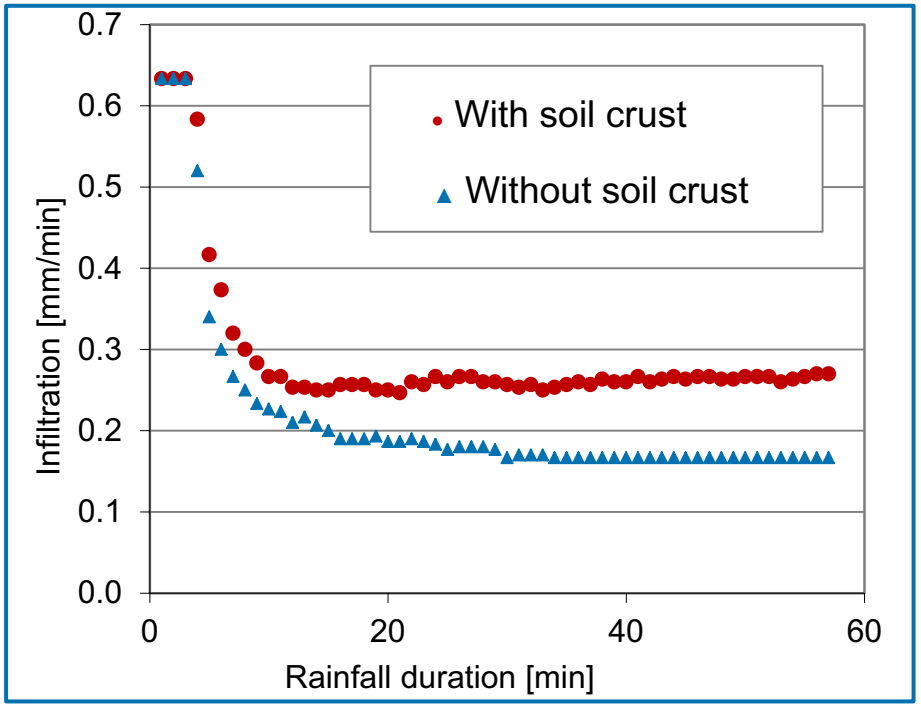
Rainfall experiment on crusted mine sites

Comparison of infiltration rates and sediment concentrations: with/without soil crust

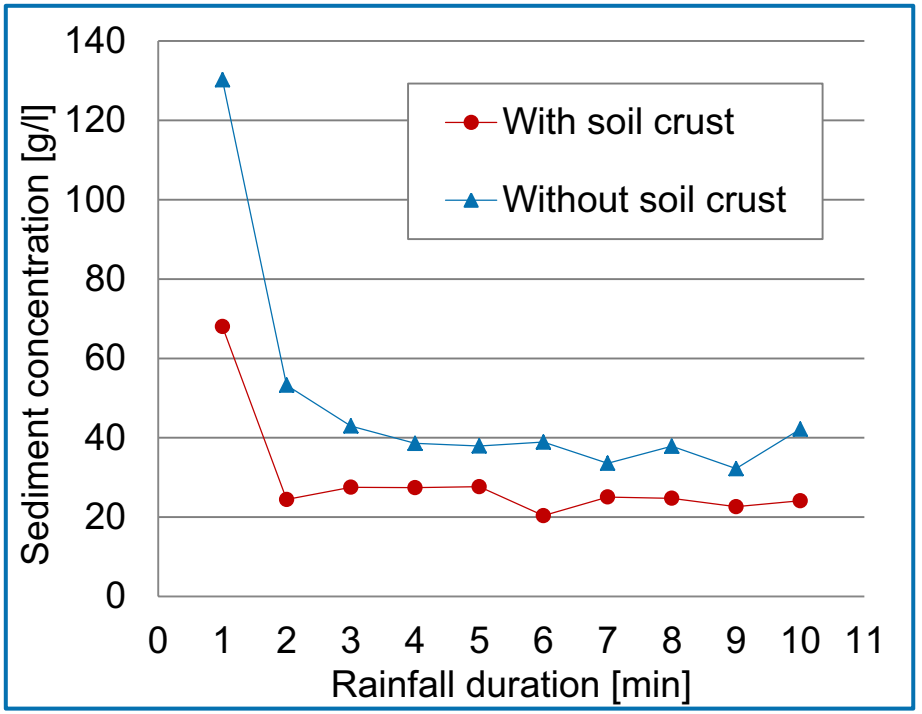
Rainfall experiment on crusted mine sites

Comparison of infiltration rates and sediment concentrations: with/without soil crust (rainfall intensity: 0,63 mm/min)

Infiltration:



Sediment concentration:



Conclusions

- ⇨ Sediment transport strongly depends on surface conditions
- ⇨ Concerning post mine sites:
  - Biological soil crusts
  - Water repellency
  - Lack of vegetation

Conclusions

- Water repellency contributes to increased surface runoff
- Concentrated runoff in surface depressions produces high erosion rate
- Calibration factor for water repellency enables use of EROSION 3D for modelling erosion processes on post minesites

Thank you for your attention!

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