3D mud deposition modelling in urban areas considering settlement structures in DEMs

Sarah Annika Arévalo¹, Jürgen Schmidt

¹arevalo@tbt.tu-freiberg.de
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Muddy floods

**Definition:** large quantities of soil particles suspended in surface runoff from agricultural land (Boardman et al. 2006)

**Damages:**
- inundation
- sediment deposits on streets, gardens, etc.

**Factors:**
- A hilly landscape
- Susceptibility of the agricultural soil to erosion
- Occurrence of heavy rain storms
- Proximity of agricultural land to urban areas
- Structure of the settlement area
Modelling of muddy floods

Muddy floods are an off-site impact of soil erosion, thus a soil erosion model is applied

⇒ EROSION 3D

Challenges:

• small study area (of about a few hectares)
• small scaled settlement structures

⇒ 1m grid
EROSION 3D...

... is a physically based erosion model that predicts water erosion for single rain events

... is also able to calculate sediment depositions

... has got a limited number of input parameters:

- precipitation data
- DEM
- soil properties

... is grid-based

... is implementing GIS data

... for more information have a look on:

www.erosion3d.tu-freiberg.de
Case study: Oberlungwitz, May 2004

• severe spring rainstorm (41.5 mm)
• inundation of a settlement, streets and gardens covered with mud
• runoff and sediment delivered from an upslope field cultivated with corn
Soil:
- map / field investigation

Agricultural management:
- crop rotation, tillage

Land use

Soil parameters:
- grain size distribution
- organic carbon
- initial moisture
- bulk density
- erodibility
- hydraulic roughness
- cover
- skin factor

Topography:
- DEM

Rain event:
- intensity
- duration

ID-Grid

Parameter-Table

EROSION 3D

Output:
- surface runoff
- erosion / deposition
erosion/deposition
[kg/m²]

- < -25
- -25 - -2.5
- -2.5 - -0.25
- -0.25 - 0.001
- 0.001 - 0.25
- 0.25 - 2.5
- 2.5 - 25
- 25 - 250
Urban surface structures:

- houses
- streets
- pavements
- parking areas
- ditches
- dams
- ...

→ generally not represented in DEMs
Soil:
- map / field investigation

Agricultural management:
- crop rotation, tillage

Land use

Soil parameters:
- grain size distribution
- organic carbon
- initial moisture
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- erodibility
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Topography:
- DEM

ID-Grid

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EROSION 3D

Output:
- surface runoff
- erosion / deposition

Rain event:
- intensity
- duration
DEM + land use information + relative object height

![DEM map with relative height information]
without surface structures
Changes in surface structures

Example: ditch that was removed in the beginning 1990’s

The ditch can be implemented in the DEM as easy as the other surface structures.
without ditch
Conclusions:

• Surface runoff strongly depends on settlement structures

• It is possible to model muddy floods on very small scale, considering the anthropogenic surface structures in the DEM

• Landscape changes as a result of human constructions can be evaluated

Outlook:

• Evaluate protection measures

• Apply for planning processes of settlements
Thank you for your attention!

www.erosion3d.tu-freiberg.de

Sarah Annika Arévalo
Boden- und Gewässerschutz - TU Bergakademie Freiberg
arevalo@tbt.tu-freiberg.de