Comparison of Two Landscape Evolution Models in the Belgian Loess Belt

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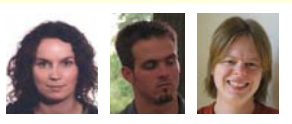

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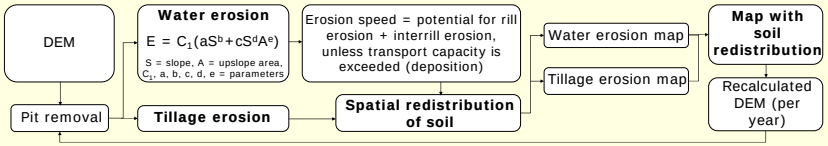
Introduction I

Several landscape evolution models exist that work on a millennial time scale. However, these models are often not spatially evaluated against observed data. Overall, the influence of choices in process description on the model results is not always clear.

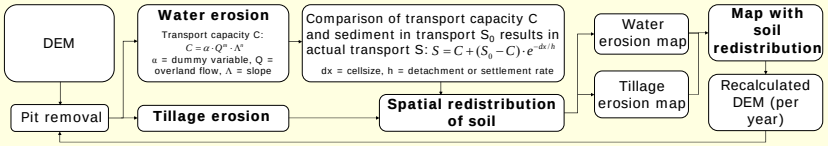
In this study, the performance of the two landscape evolution models WaTEM LT and LAPSUS is tested in the Belgian loess belt. They are both topography-based and spatially explicit, but use different process descriptions.

Model descriptions II

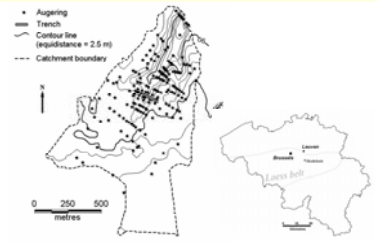
WaTEM LT (Peeters et al., 2006)



LAPSUS (Schoorl et al., 2004)



Study site III



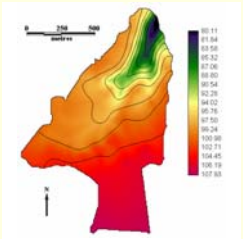
Evaluation of the models is based on historic soil erosion and deposition values derived from soil profile truncations in a 100 ha catchment in Nodebais, Belgium (Rommens et al., 2005).

The Nodebais catchment: data + location

Methods

a) 2D application

- Calibration: 2D transect - field trench in Nodebais
- Four resolutions: 5 m, 10 m, 15 m and 20 m
- Model runs: forwards in time, starting from original topography
- Validation: transect at the other side of the valley



The Nodebais catchment: DEM

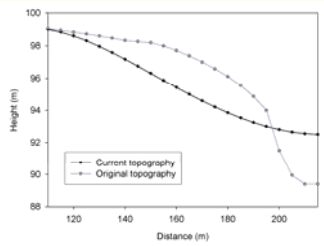
b) 3D application

- Calibration: Nodebais catchment, 20 m resolution
- Original topography unknown → backwards in time!
- Validation: close-by catchment of Hamme-Mille

Model efficiency $MEF = 1 - \sum (Y_{obs} - Y_{pred})^2 / \sum (Y_{obs} - Y_{mean})^2$

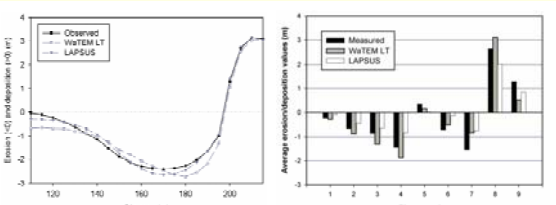
2D: based on raster cells - 3D: based on landscape element classes

IV



Field trench: original + current topography

Results and discussion V



2D (left) and 3D (right) results of WaTEM LT and LAPSUS

Both models perform excellent on all the resolutions and scales:

- *MEF* values between 0.85 and 0.99
- LAPSUS: better results in 2D
- WaTEM LT: slightly better in 3D

Optimal parameter values are similar for different resolutions.

Validation also shows good results.

Still, LAPSUS has a problem with 3D backward calculation, caused by the backward interaction of the water-driven sediment redistribution and tillage, expressed by wrong deposition patterns around the thalweg.

Conclusions VI

The more complex process description of LAPSUS improves the results of detailed 2D landscape evolution simulations. However, the simpler process description of WaTEM LT is equally capable of reproducing the overall 3D soil redistribution patterns. Apparently, the gains from a more complex process description are offset by a greater uncertainty in the input data. This illustrates that the complexity of process descriptions should be a function of the research setting.

• Peeters I., Rommens, T., Verstraeten, G., Govers, G., Van Rompaey, A., Poesen, J., Van Oost, K., 2006. Reconstructing ancient topography through erosion modelling. Geomorphology 78, 250-264.
• Rommens, T., Verstraeten, G., Poesen, J., Govers, G., Van Rompaey, A., Peeters, I., Lang, A., 2005. Soil erosion and sediment deposition in the Belgian loess belt during the Holocene: establishing a sediment budget for a small agricultural catchment. The Holocene 15, 1032-1043.
• Schoorl J.M., Boix-Fayos C., De Meijer R.J., Van der Graaf E.R., Veldkamp A., 2004. The 137Cs technique applied to steep Mediterranean slopes (Part II): landscape evolution and model calibration. Catena 57, 35-54.