

Modeling soil erosion and analyzing reservoir sedimentation at hillslope and small catchment scale in Burkina Faso

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Introduction

Soil erosion and reservoir sedimentation are major factors of land degradation in the semi-arid environment of Burkina Faso. Both, the loss of nutrient-rich topsoil from hillslopes and the rapid siltation of small reservoirs cause severe agricultural problems, especially in countries with temporally limited water resources.

Therefore, it is proposed to quantify on-site and off-site effects of soil erosion simultaneously and to identify adequate land management strategies to prevent topsoil from being eroded.



Hillslope scale

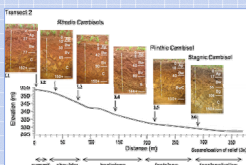
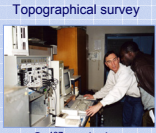
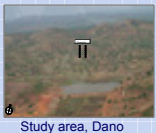
- to analyze soil loss along soil transects by considering slope-specific variations in soil properties (catena concept);
- to simulate soil erosion and deposition along these transects by the ^{137}Cs approach and the physically-based WEPP-model;
- to predict the effect of land management strategies (e.g., stone lines, min. tillage and contour farming) on soil erosion.

Research objectives

Small reservoir scale

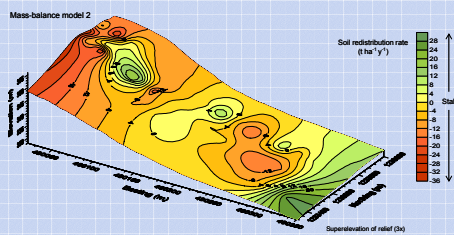
- to quantify siltation rates and to analyze sediment budgets of small reservoirs;
- to predict soil erosion and sediment accumulation by the empirically-based WaTEM/SEDEM model;
- to identify the most affected landscape zones and to create a soil erosion hazard map for the loba-District.

Data and methods

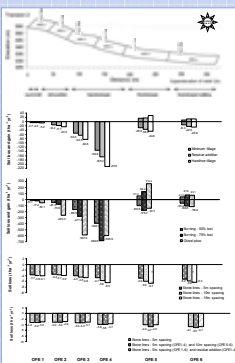


Soil catena at a hillslope in Dano, south-western Burkina Faso

The horizon description of soil profiles indicates that diagnostic soil properties are closely related to specific pedo-geomorphic processes ascribed to each individual hillslope position. Soil redistribution rates calculated by the ^{137}Cs technique show max. erosion rates of $37 \text{ t ha}^{-1}\text{yr}^{-1}$ at the summit and shoulder position and max. deposition rates of $29 \text{ t ha}^{-1}\text{yr}^{-1}$ at the footslope/valley position. The results correspond well with catenary soil development.



Spatial pattern of soil erosion/deposition at Dano hillslope based on ^{137}Cs conversion model

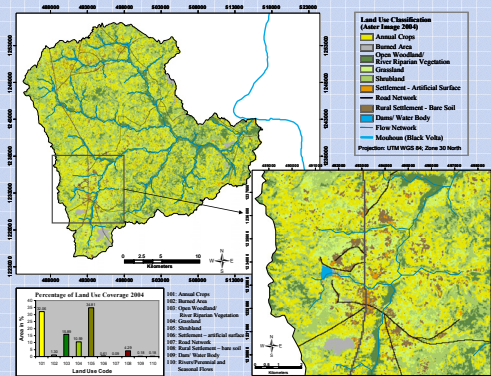


Effect of land management options on simulated soil loss by WEPP-model

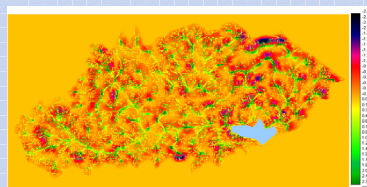
Simulated soil loss by WEPP-model varies highly along the hillslope, but can be reduced significantly if adequate soil and water conservation methods (e.g. stone lines, min. tillage, mulching/residue addition) are applied on erosion-prone hillslope positions.

Results

The sediment storage of small reservoirs is analyzed by bathymetric surveys and retrieval of sediment cores. By knowing age, size, depth and sediment thickness of the reservoirs, the sediment loss from the contribution area could be calculated for a specific time period. Remote sensing techniques are used to extend land cover data from field to larger landscape units.



Land Cover Map of the loba-Catchment and enlargement of the area around Dano based on classified Aster Image 2004

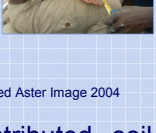


Water erosion rates ($\text{t ha}^{-1} \text{yr}^{-1}$) simulated by WaTEM (developed by K.U. Leuven, Belgium). Positive values refer to net sediment deposition, negative values to net erosion. The water surface of the dam is presented in light blue.

The spatially distributed soil erosion and sediment delivery model WaTEM/SEDEM simulates the impact of soil conservation and sediment control measures. The example shows average soil erosion rates of $2.3 \text{ t ha}^{-1} \text{yr}^{-1}$ for the sub-catchment of Fafu.



Data and methods



Outlook and recommendations

Considering the high erosion risk and the low nutrient status of soils in Burkina Faso, soil conservation techniques should have both a physical-mechanical function to control runoff and soil loss and a biological-agronomical impact to restore soil nutrients.