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Modelling Water Flow and Sediment Transport in Paddy Cascades in Northwest Vietnam

REBECCA SCHAUFELBERGER, CARSTEN MAROHN, GEORG CADISCH

University of Hohenheim, Inst. of Plant Production and Agroecology in the Tropics and Subtropics, Germany

Abstract

Deforested mountainous watersheds in SE Asia under continuous maize cropping are prone to erosion. Erosion decreases soil fertility in the uplands and may have fertilising or silting effects on paddy fields in the lowlands. In paddies, ponding water and decreased flow velocity of run-off cause settling of suspended particles carrying nutrients and organic matter. LUCIA (Land Use Change Impact Assessment tool), a spatially explicit and dynamic model developed at the University of Hohenheim simulates water and nutrient cycles, plant growth and erosion on landscape-scale. However, paddy cascades, their specific topography and bunds and their influence on deposition are not part of the model up to now. The aim of this study was a) to develop a standalone model simulating water flow and sediment transport in paddy cascades that can be integrated into LUCIA, b) a first plausibility validation of the new model based on field data from Northern Vietnam.

In a paddy cascade in Chieng Khoi, Son La, inflow, surface flow between paddies and outflow were measured with water clocks. Additionally, turbidity measurements were conducted in all flows. These data were used for model calibration. During normal baseflow (no rain) the inflow was 49 m³ per day resulting in an outflow of 24 m³. Taking the same inflow, the modeled outflow was 20 m³ day⁻¹. Modeled bund percolation, cross flow and percolation were in the range found in literature. Flows fitted simulated rain peaks.

Sediments eroded in the uplands are transported with the inflowing water into the cascade. Suspended particles in the water remaining in the paddy field are assumed to settle within one day. Sediment concentration changes from inflowing to outflowing water, while discrimination between particle size classes is not included in the model. A measured sediment concentration decrease (-85 %) from cascade inlet to outlet was also obtained with the model.

A next step will be the integration of the paddy model into LUCIA. In addition, more field data are needed for further validation.

Keywords: Hydrology, landscape modelling, paddy model