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"Development on the margin"

Modelling the Effects of Changing Crop Patterns and Management Practices on N and P Loads to Surface and Ground-water in a Semi-humid Catchment (West Africa)

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Abstract

Assessment studies of land and water degradation have developed from simple descriptions, based on monitoring and sampling to the analysis of multiple scenarios using simulation models. This increasingly involves the use of calibrated and validated simulation models to calculate soil nutrient losses as well as nitrogen and phosphorus fluxes to surface and groundwater system. Physical based models like SWAT as applied in this study are able to simulate the dynamic of soil nutrient pools at the field scale with various inputs: fertilisation, manure or residue application, fixation by symbiotic or non-symbiotic bacteria, and atmospheric fixation. In this work soil nitrogen and phosphorus pools are adjusted and local management practice considered to simulate water, sediment, and nutrient delivery to the stream flow at the Donga-Pont river catchment outlet (586 km^2) in the Republic of Benin (West Africa). At that scale crop patterns are not often mapped, leading to simplifications in the model application with the risk to cause a bias in the results. In this study, the available land use map derived from satellite image has been refined, allowing the evaluation of three modelling scenarios: Sc0 - agricultural lands were refined into 12 cropping systems with fertiliser supply only to cotton, rice and maize as common in Benin, Sc1 - assuming that all crops receive similar fertiliser input, and Sc2 - no refinement of land use map and no fertilisation were considered. Observed water yield, sediment yield and N load are well simulated in the scenario Sc0. Common simplifications (scenarios Sc1 and Sc2) lead to a distinct bias in the results. For reference scenario Sc0 considering a fertilisation rate (mineral N) of 30 $kg\,ha^{-1}\,y^{-1}$, nitrate loads to surface and ground-water were simulated as 53 $tons\,y^{-1}$ and 738 $tons\,y^{-1}$ respectively for the whole catchment. Silt and clay particle load sums up to 35,160 $tons\,y^{-1}$ with an associated organic nitrogen load of 88 $tons\,y^{-1}$. Simulated land use and climate change effects for the year 2030 result in a decrease up to 20 % in sediment yield and an increase up to 50 % in related nitrogen load compared to the Sc0 scenario.

Keywords: Climate change, crop patterns, land degradation, land use, management practice, AWAT, water quality

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