Vegetative Filter Strips to Control Surface Runoff Phosphorus Transport from Mining Sand Tailings in the Upper Peace River Basin of Central Florida

Yi-Ming Kuo[1], Rafael Muñoz-Carpena[1], Yuncong Li[2], Willie Harris[2] and Dean Rhue[2]
[1]Agricultural and Biological Engineering; [2]Soil and Water Science, University of Florida

Runoff non-point source pollution from phosphate mining areas is a potential risk to ecosystems in many parts of the world. Mining sand tailings shape the landscapes in reclaimed lands at the upper Peace River basin of Central Florida. The objectives of this research were to assess the surface runoff pollution loads from the mining sand tailings in Central Florida and to evaluate and model the efficiency of vegetative filter strips (grass buffers) to control phosphorus (P) runoff from these areas. Field experimental data were collected from two sites with different slopes, source-to-filter ratios, and soil properties representative of the surrounding area. The numerical model VFSMOD-W was used to predict overland flow and sediment trapping within the filter, and was linked to a simplified P transport algorithm to predict total P (TP), particulate P (PP), and dissolved P (DP) trapping. The model was calibrated using a global inverse optimization technique and considering uncertainty in the measured data. X-ray diffraction showed that apatite represents 95% of the source of P from the surface material, with related TP concentrations of 17.0-25.7 g/kg. Apatite dissolution, rather than desorption from metal oxides, was found to be the dominant soil P release mechanism during runoff. Measured runoff DP concentrations were 0.4-3.0 mg/L. The longer, steeper and less permeable source areas studied (4.3% slope, runoff lengths of 40 m, saturated hydraulic conductivity K_s=1.6 cm/h) yielded an average of 4.5 Tm/ha-year of sediment, 104 kg/ha-year of TP, and 2.21 kg/ha-year of DP. Runoff volume, sediment, TP, and DP were reduced at least by 62%, 97%, 96%, and 66% with 6 m vegetative filter strips in all sites studied. VFSMOD-W can predict runoff and sediment and PP transport well (Nash and Sutcliffe efficiency from 0.60 to 0.99) for all but small events (peak runoff flow rate in the filters < 0.4 L/s) due likely to large measurement uncertainty in the small events. A good prediction of DP filter outflow was found when considering rainfall impact on DP apatite release. The inclusion of the uncertainty of measured data provides a more realistic model evaluation. The successful testing of VFSMOD-W will serve as the basis for adoption of the model by managers to design optimal filters to control P runoff from phosphate mining sand tailings.

Keywords: phosphorus, apatite, vegetative filter strip, non-point source pollution, phosphate mining area, sediment