Geophysical Research Abstracts
Vol. 12, EGU2010-5626-1, 2010
EGU General Assembly 2010

Carbon and nitrogen dynamics in a soil profile: Model development

Jordi Batlle-Aguilar, Alessandro Brovelli, and D. Andrew Barry

Ecological Engineering Laboratory (ECOL), Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland (jordi.batlle@epfl.ch, alessandro.brovelli@epfl.ch, andrew.barry@epfl.ch)

In order to meet demands for crops, pasture and firewood, the rate of land use change from forested to agricultural uses has steadily increased over several decades, resulting in an increased release of nutrients towards groundwater and surface water bodies. In parallel, the degradation of riparian zones has diminished their capacity to provide critical ecosystem functions, such as the ability to control and buffer nutrient cycles. In recent years, however, the key environmental importance of natural, healthy ecosystems has been progressively recognized and restoration of degraded lands towards their former natural state has become an area of active research worldwide. Land use changes and restoration practices are known to affect both soil nutrient dynamics and their transport to neighbouring areas. To this end, in order to interpret field experiments and elucidate the different mechanisms taking place, numerical tools are beneficial.

Microbiological transformations of the soil organic matter, including decomposition and nutrient turnover are controlled to a large extent by soil water content, influenced in turn by climatic and environmental conditions such as precipitation and evapotranspiration. The work presented here is part of the Swiss RECORD project (http://www.cces.ethz.ch/projects/nature/Record), a large collaborative research effort undertaken to monitor the changes in ecosystem functioning in riparian areas undergoing restoration. In this context we have developed a numerical model to simulate carbon and nitrogen transport and turnover in a one-dimensional variably saturated soil profile. The model is based on the zero-dimensional mechanistic batch model of Porporato et al. (Adv. Water Res., 26: 45-58, 2003), but extends its capabilities to simulate (i) the transport of the mobile components towards deeper horizons, and (ii) the vertical evolution of the profile and the subsequent distribution of the organic matter. The soil is divided in four compartments, each representing a different "functional unit", having different thickness. The three shallower compartments, each variably saturated, correspond to the top soil, the root zone and an intermediate soil layer between the root zone and the aquifer. The deeper compartment represents the unconfined aquifer that receives nutrients infiltrating through the soil profile and always remains water-saturated. Carbon and nitrogen infiltration in the soil profile and their cycling are described by a set of coupled non-linear ordinary differential equations that are numerically integrated.

To show the model capabilities in simulating soil nutrients transformations and transport and to illustrate how the model can be used to predict the changes in soil functioning as a result of land use changes, several realistic scenarios, with different soil and vegetation types, were modelled using a stochastically generated precipitation time series.