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Modelling and monitoring vegetation and evapotranspiration on an anthropogenic grassland succession in the Andes of Ecuador

B. Silva and J. Bendix
University of Marburg, Germany (brenner.silva@students.uni-marburg.de)

In the eastern Andes of southern Ecuador the infestation of pasture (mostly C4-grass Setaria sphacelata) by the aggressive bracken fern (Pteridium sp.) still is an unsolved problem. Environmental and exogenous factors and direct plant competition have been hypothesized to drive bracken occurrence. Special attention is given to pasture burning, which stimulates bracken growth, and is common in the relative dry season (Oct-Dec). However, no knowledge is available for a quantitative hypothesis investigation on bracken occurrence under current and future local climate. In this work a modeling approach is presented, in which initial investigations support the application of a two-big-leaf model, and parameterization and model forcing are made with extensive data on physiological traits and on the physical environment. Our main aims here are (i) to show field investigations on a plant scale, which are the basis for a proper model parameterization; and (ii) to provide initialization data, which is based on estimation of green leaf area index from very-high and high resolution optical remote sensing (air-photos and Quickbird images); (iii) to simulate vegetation succession after burn on an experimental site, using in situ climate data and future climate-change scenarios.

The modeling approach is based in the main on the vegetation dynamic model called Southern Bracken Competition Model (SoBraCoMo), which has been coupled to a hydrological model written on the catchment model framework (CMF), to simulate soil-vegetation dynamics. Main initialization variables are biochemical parameters (quantum and carboxylation efficiency) and the green leaf area index (green-LAI). Forcing data include soil, leaf and air temperature, soil and air humidity and radiation. The model has been developed and tested on the experimental site (2100 m asl) in the Rio San Francisco Valley, Ecuador. Simulation results on the burn experiment of 2009 showed that stimulation by fire could not boost fern productivity and Setaria pasture showed to be as competitive as bracken. A productivity of 3.2 kg/m2/year was calculated for Setaria pasture against 2.7 kg/m2/year for bracken fern, while a slightly higher evapotranspiration 968 mm/year was calculated for Setaria canopy in comparison with that of bracken with 849 mm/year. In addition, model runs using future climate change scenarios point to higher competitiveness of Setaria pasture. Explanations are given by comparing independent data and different observations within the study area and discussions emphasize data acquisition issues and the on-going modeling approach.

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