SANREM CRSP

Research Brief

Sustainable Agriculture and Natural Resource Management
Collaborative Research Support Program

Issue No. 10

Developing appropriate nonpoint source pollution models for the tropics

Nonpoint source (NPS) pollution is a growing problem around the globe. Many developed countries already have significant NPS pollution problems. Agriculture, a significant source of NPS pollution, contributes nutrients, sediments, and pesticides to surface and ground waters. In developing countries where conventional farming is becoming more common, watersheds are experiencing increases in NPS-related water quality problems.

Understanding how to manage NPS pollution as it migrates through the environment is challenging. Pollution models, which show the movement of pollutants through a particular environment, are often utilized for evaluating NPS pollution controls. These models are increasingly used to study NPS pollution in the tropics; however, many of the models used for pollutant control evaluation were developed using temperate soils, with very different characteristics from the tropics' agricultural soils.

Creative Commons Attribution-ShareAlike 2.0

Management of nonpoint source pollution from small scale and conventional farms in the tropics can be facilitated through the use of improved agro-ecosystem models.

Modeling challenges in the tropics

Realizing the shortcomings of applying models developed from temperate soils to the tropics, SANREM researchers Marco A. C. Caiado of Instituto Federal do Espírito Santo in Brazil and Conrad D. Heatwole of Virginia Tech, completed a literature review to determine appropriate nutrient parameter values for tropical soils. The literature values were then compared to the default parameter values in the Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) model to assess differences with a model developed with North American data. Accounting for soil characteristic differences in pollution models can improve outputs and applicability within a range of climates and soil types.

Soil nutrient values for the tropics were found in studies from Brazil, Dominica, Guadeloupe, San Lucia, Malaysia, Hawaii, Thailand, Sudan, Zambia, Australia, Venezuela, Nigeria, Martinique, Columbia, Ethiopia, Kenya, Costa Rica, Peru, Trinidad, Nigeria, and Ghana. The parameters reviewed included soil carbon to nitrogen ratio (C:N), potentially mineralizable nitrogen, nitrate, ammonia, and various forms of phosphorus (P), including soil organic P, labile P, and mineral P.

kauaiplantationrailway.com

Office of International Research, Education, and Development
Virginia Polytechnic Institute and State University
526 Prices Fork Road
Blacksburg, VA 24061-0378

Phone: (540) 231-1230
Fax: (540) 231-1402
Email: sanrem@vt.edu
www.oired.vt.edu/sanremcrsp

Parameter	Default GLEAMS value	Suggested value for tropics
C:N ratio	10:1	13:1
Potentially mineralizable nitrogen (ratio of N_0 / N_{Total})*	0.165	0.14
Nitrate	5 µg/g soil	10 µg/g soil
Ammonia	2 µg/g soil	19 µg/g soil
Soil organic P* (surface horizon)	SORGP = 1130 TN* + 44.4	Various new linear equations
Soil organic P* (other horizons)	SORGP = 1464 TN	Various new linear equations
Labile P (% of SORGP* in highly weathered soils)	5.6	5.6
Mineral P (as a function of PSP*)	PSP = 0.46 - 0.0916 * ln(CLAYPCT*)	PSP = 0.14

* N_0 = mineralizable nitrogen; N_{total} = total nitrogen; P = phosphorus; TN= % total nitrogen; SORGP = soil organic phosphorus; PSP – soil sorption phosphorus; CLAYPCT = percent of clay in soil

Need for regionally specific parameters

The research found that **all but one** of the default values or equations are improved for nutrient modeling in the tropics if the GLEAMS model is altered (see table above for all parameters). For example, the default C:N ratio in GLEAMS is 10:1. Review of the literature found actual C:N ratios in tropical soils varying from 8:1 to 44.7:1. A C:N ratio of 13:1 is suggested because it represents approximately 78 percent of the soil classifications found in the tropics.

In another example, the default nitrate value for GLEAMS is half of the recommended value for tropical soils. Research identified nitrate levels between 7.7 and 14.1 micrograms (µg) per gram (g) of soil, with the area-weighted average of 10.34 µg/g soil. The current GLEAMS default value is 5 µg/g.

This research improves the GLEAMS model when applied to tropical conditions. The process of reviewing the literature is a first step in identifying appropriate parameter values for soils in regions not previously included in model development. Adjusting parameters to tropical conditions will likely improve users' ability to identify potential NPS pollutant loads and necessary pollution controls.

More information: Caiado, M.A.C. and C.D. Heatwole. 2009. Technical Note: Improved Nutrient Parameters for Modeling Diffuse Pollution in the Tropics. Transactions of the ASABE 52(3):845-849. Online at http://asae.frymulti.com/abstract.asp?aid=27403&t=1.

USAID FROM THE AMERICAN PEOPLE

SANREM CRSP is made possible by the United States Agency for International Development and the generous support of the American people through USAID Cooperative Agreement No. EPP-A-00-04-00013-00.

VirginiaTech Invent the Future