NO3-N seasonal fluctuation in soil/surface water – groundwater continuums

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Abstract

Under the scope of a project, funded through a grant from USDA's Initiative for Future Agricultural and Food Systems (IFAFFS) and aimed at improving productivity of small family farms, a program was established to address the need for environmental quality monitoring. Water quality monitoring is most important to evaluate the ecological and social impact of the project.

Objectives of the program are: to assess the effect of goat and cattle husbandry on biogeochemical cycle of elements in this small but complex agroecosystem, and promote sound adaptation options for environmental protection. The monitoring scheme is designed to obtain information about the cumulative impact of precipitation, irrigation and fertilization on soil solution, surface water and groundwater quality.

Soil liquid phase (soil solution/lysimeter water) is considered as an early environmental indicator for potential leaching of nitrogen and non-nitrogen nutrients through soil profile. Soil solution, surface water and groundwater samples were taken biweekly and analyzed for volume, pH, electrical conductivity and major nutrients content. Rainfall samples were taken from every event and the same analyses were performed. A small part of the results, i.e., NO3-N balance and dynamics are presented and discussed.

The analysis showed that monitoring of the different components of the small but complicated agroecosystems can be organized according a site-specific methodology. The assumption was made that extensive and semi-intensive pasture management is a suitable technological decision, which ensures maximum inclusion of nitrogen in the biological cycle and prevents its leakage through soil profile.

Objective

Develop a strategy for a monitoring program and utilize this approach to assess the environmental impact of extensive and semi-intensive livestock production systems.

Materials and Methods

The soil liquid phase (soil solution/lysimeter water) is considered as an early environmental indicator of potential leaching of nutrients such as nitrogen and other chemicals through soil profile.
Soil solution, surface water, and groundwater samples are taken biweekly, and rain water samples from every event. Samples are analyzed for pH, Ec and major nutrients. Preliminary results for NO3-N content of the samples collected for a 9-month period are presented.

Figure 1. Soil solution sampling procedure: Vacuum at 55-65 kPa is applied to the suction-cup lysimeters; and Soil-water samples are collected after 18-24h

Results

Climate characteristics and meteorological data of the period under investigation from both pilot sites had shown low risk for nitrogen leaching in the North Florida region. Precipitations are evenly distributed throughout the study period (Fig. 2), with mean biweekly evapotranspiration exceeding precipitation most of the time under consideration.
The data for nitrate nitrogen dynamics had shown that the precipitations are characterized with low nitrogen concentrations. NO3-N content in rainfall is far below maximum permissible level (MPL) of 11 mg/L for Quincy site (Fig. 3 – A), however, a maximum of 7.35 mg/L is registered in the middle of May. For Santa Fe site, mean and seasonal NO3-N values are higher than in Quincy, with two rainfalls in July 2-time higher than MPL (Fig. 3 - B).
The analysis of soil solution (Fig. 1) data showed significant variation in nitrate nitrogen content. Top soil layer (2ft) of both pastures in Quincy yielded considerable quantities of NO3-N but nitrate content is below the MPL, and further decreasing with the depth (Fig. 4 – A). A pick is observed under goat pasture in May for the three depths. Comparing the data for NO3-N content in soil solution from pastures and fallow/arable land is shown that NO3-N content in soil solution from fallow increased with the depth, and exceeded the MPL at 4 and 6 ft during the growing season. The data for the dynamics of nitrate nitrogen content in soil solution from Santa Fe's pastures showed a higher concentration (Fig. 4 – B). Thus, the NO3-N content from all depths exceeded MPL, which could a precondition for water bodies enrichment with nitrates.
The obtained data for the dynamics of nitrate nitrogen content in different water sources at Quincy site shoed that throughout study period NO3-N content is far below the MPL (Fig. 5)

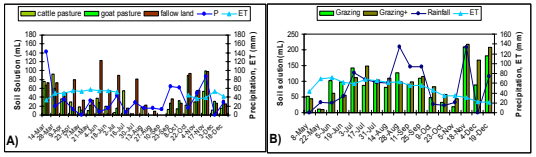

Figure 2. Soil solution rates, and biweekly Precipitation and Evapotranspiration: A) Florida A&M University R&E Center, Quincy, Florida; B) University of Florida Santa Fe Beef Research Unit, Alachua, Florida

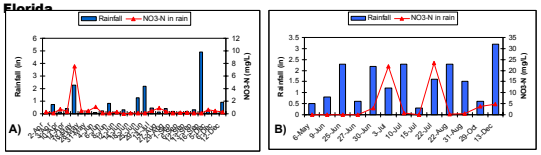

Figure 3. Seasonal dynamics of Rainfall and NO3-N content in 2002: A) Florida A&M University R&E Center, Quincy, Florida; B) University of Florida Santa Fe Beef Research Unit, Alachua, Florida

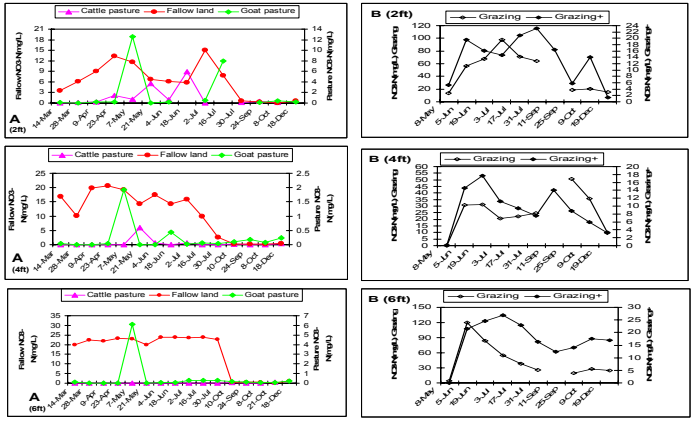

Figure 4. NO3-N content in soil solution under different land uses and depths (2, 4 and 6 ft): A) Florida A&M University's R&E Center, Quincy; and B) University of Florida's Santa Fe Beef Research Unit, Alachua (Cattle pastures: 1-grazing only, and 2-grazing+medicated feed)

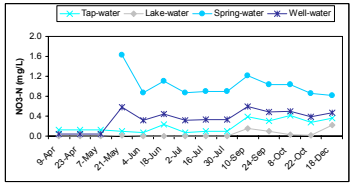

Figure 5. Dynamic of NO3-N content in the water samples from different sources, Florida A&M University R&E Center, Quincy

Conclusion

A methodology for assessing the impact of natural factors and pasture management is established.
Tension (suction cup) lysimetry technique can be used in monitoring program of livestock production.
There is significant difference in nitrogen content comparing grassland and fallow land (N increases with the depth of fallow land.