A NEW GIS APPROACH TO ASSESS NITROGEN MANAGEMENT ACROSS THE USA

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ABSTRACT

Nitrogen has an essential function in the maximization of farmers' agricultural output and economic returns. This element is very dynamic and mobile, characteristics that create challenges in its management and that can contribute to considerable off-site nitrogen losses. The magnitude of these losses can be affected by site-specific physical and chemical factors. These physical and chemical factors can vary greatly across the landscape, further increasing the complexity of managing nitrogen. A new tool that can be used to quickly integrate spatial and temporal variabilities and contribute to the assessment of risky landscape-management combinations has recently been developed: the NLEAP-GIS tool can facilitate the download of U.S. GIS soil databases as well as climate databases that have been collected by weather stations across the U.S., and quickly format these databases to conduct evaluations across a given site-specific field. Users will need to set up the management data to be evaluated. A national NLEAP-GIS nitrogen management database that will be available to users is being developed to help integrate soil, weather and management databases. Results from studies across several U.S. regions using GIS, ranging from corn-soybean rotations in the North Atlantic region, to manure applications in the Midwest, to irrigated small grain, vegetable and cover crops grown in the western United States show that NLEAP-GIS is a useful tool for assessing the effects of nitrogen inputs across risky landscape-management combinations and can potentially be used to assess the effects of nitrogen management on nitrogen use efficiencies across regions of the USA.

Keywords: GIS, precision conservation, precision farming, nitrogen trading tool, NLEAP GIS, nitrate leaching

INTRODUCTION

Cropping systems throughout the world require nitrogen (N) inputs to maintain their viability and to maximize their production; most soils cannot meet the requirements of cropping systems for maximum production without the addition of nitrogen. Even if a soil is already loaded with nitrogen, the system may still need additional nitrogen inputs at certain times of year because this element can be lost during the growing season, due to unpredicted, high rainfall events or irrigation, which can move the nitrogen below the root zone and/or increase the denitrification potential. Nitrogen and water management are critically important to increasing nitrogen use efficiencies and reducing losses, especially in risky landscape – management combinations (e.g. crops with growing shallow root systems, such as lettuce or potato, grown on an irrigated loamy sand soil). There is potential to use crop rotations and deeper scavenger crops to minimize nitrogen losses, scavenge leached nitrates from the previous crop and even mine nitrates from groundwaters, but management and implementation of best practices is key (Delgado, 1998, Delgado et al. 2001). Correlation of nitrogen inputs with nitrogen losses and impacts to water bodies and groundwaters across the world's agroecosystems is being reported (Follett and Hatfield, 2008, Delgado and Follett 2010, *in press*). Nitrogen losses across agricultural systems of the USA increase if excessive N inputs are conducted, and these losses can be higher than those observed from natural systems and potentially be quickly moved in tiles systems and transported to water bodies (Randall et al. 2008; Delgado and Follett 2010, *in press*). Similarly, across key, highly productive agroecosystems in the world such as the Pampas in Argentina, the Mediterranean regions of Europe, and the North China Plain, higher than necessary N inputs are correlated with higher N losses that could potentially impact groundwaters (Li et al. 2007, Lavado et al. 2010, *in press*); De Paz et al. 2009). Better management of resources and environmental management while continuing to produce food will be key to addressing the strong pressure for maximizing yields that accompanies population growth (Kummerer et al. 2010).

There is an emerging need to assess the potential effects of management systems on nitrogen losses. Nitrogen management has been reported as a key component of efforts to increase use efficiencies and reduce these losses (Delgado and Follett 2010, *in press*). Recent scientific and technological progress in nitrogen management such as nitrogen sensors, use of cover crops, improved water management, precision farming, and nitrogen trading tools can significantly contribute to reduced losses of reactive nitrogen to the environment and to improvements in water quality conservation efforts (Schepers and Raun 2010, *in press*; Long and Pierce, 2010, *in press*; Lal, 2010, *in press*; Dabney et al. 2010, *in press*). Independent of the source of nitrogen inputs, sound management is key to decreasing its losses to the environment and organic systems, as adequate management practices can serve to cycle nitrogen inputs (Hepperly et al. 2010, *in press*). There are reports that the use of cover crops systems is increasing nitrogen use efficiencies and reducing nitrogen losses (Dabney et al. 2010, *in press*) and even increasing crop yields and quality, especially in limited irrigation systems that use summer cover crops (Delgado et al. 2007). Additionally, buffers systems have been found to be useful tools for reducing the transport of nitrogen offsite (Dosskey et al., 2002, 2005, 2007, Fares et al. 2010, *in press*).

Assessment tools such as computer models, nitrogen trading tools, and even simpler, quick tools such a nitrogen index can be used to assess the effects of management on the conservation of our biosphere (Delgado et al. 2010 *in press*; Gross et al. 2010, *in press*). There are a large number of nitrogen models that can be used to assess nitrogen management practices (Shaffer et al. 2001). One such model is NLEAP, which can be used to assess nitrogen pathways and management (Shaffer et al. 2010, *in press*). Shaffer et al. 2010 (*in press*) presented the algorithms NLEAP uses for its calculations. Delgado et al. 2010 (*in press*) discussed the capabilities of this tool to assess the effect soil management has on N losses to the environment and how it can contribute to global conservation efforts. An analysis of several case scenarios across the USA are shown (Figure 1). For additional details about the advantages and disadvantages of this quick approach to conducting analyses of nitrogen losses and environmental impact across USA regions, see Delgado and Follett 2010 (*in press*), Shaffer et al. 2010 (*in press*) and Delgado et al. 2010 (*in press*) when published by the Soil and Water Conservation Society by the fall of 2010.

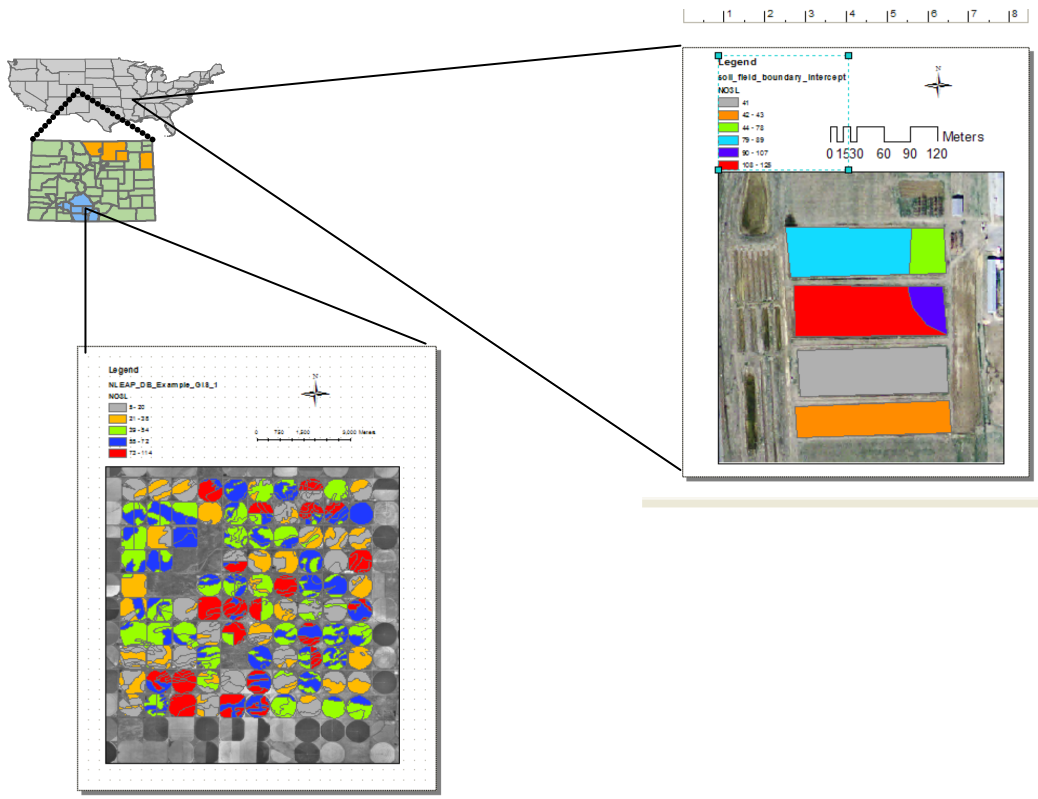

Figure 1. A stand-alone NLEAP-GIS 4.2 can be used to quickly evaluate the effects of management practices on N losses and nitrogen use efficiencies across different risky landscape and cropping systems combinations.

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