Assessing the effect of agricultural practices in an area declared vulnerable to nitrate pollution using a GIS and a crop simulation model

Project financed by: Comunidad Autónoma de la Rioja (ECCYSA)
Duration: May 2005- December 2008
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There is an increased concern about the high nitrate concentration found in many surface and ground waters bodies, because of its contribution to environmental pollution (eutrophication of continental and coastal waters). This concern is considered in several European directives such as the diffuse pollution by Nitrate (91/676/CEE), the Integrated Pollution and Prevention Control (96/61/EC) and the Water Framework directives (2000/60/EC). Those directives, and particularly the 91/676/CEE, encouraged to conduct action plans to evaluate and control nitrate pollution in areas declared vulnerable.

The Government of La Rioja (North Spain) declared two nitrate vulnerable zones (NVZs) (BOR nº 143, Novembre the 26th 2002). This study focuses on one of them, the Glacis de Aldeanueva del Ebro. The NVZ comprise a total of 1054 ha mainly devoted to vineyard, and is located over a confined aquifer connected to the Ebro River water system. Nitrate concentration in the aquifer is over 100 mg NO_3-N L^{-1}, showing a real problem of water pollution. The overall objective of the project is to study the contribution of agricultural practices to the nitrate pollution of the aquifer, and to evaluate the effect of different strategies to control nitrate leaching. To achieve this goal we are using the crop simulation model STICS connected to a geographic information system (GIS).

For this purpose, the crop-soil simulation model STICS coupled with a geographic information system was used to estimate the amount of NO_3 leaching and to assess the ability of alternative management practices to reduce NO_3 leaching in a NVZ in La Rioja, Spain. Model performance was examined by comparing the simulations and measurements of irrigated grapevine crops (variety Tempranillo) over various soil types. The measurements were obtained from five pilot plots over a period of three years and included the mineral N, the soil water content and the crop N nitrogen content. Eight management scenarios were simulated, combining two NO_3 concentrations of irrigation water and four levels of organic manure applications. The simulations identified good agricultural practices (GAP) for mitigating NO_3 pollution. High soil mineral nitrogen (SMN) and water pollution were driven by both the NO_3 concentration of irrigation water and the level of organic manure application. The use of aquifer water for irrigation would lead to diminish aquifer pollution at the expense of maintaining high SMN, non desirable for grape quality production. River water would offer an opportunity for the recovery of soils and the improvement of underground water quality if the application of organic manure was limited according to soil type. Differences in NO_3 leaching of the NVZ soils depended more on their ability to store N than on their annual drainage.

Información más detallada puede encontrarse en:
Ruiz Ramos M., Gabriel JL, Vázquez N, Quemada M. 2011. Simulation of nitrate leaching in a vulnerable zone: effect of irrigation water and organic manure application. Spanish Journal of Agricultural Research. 9: 924-937.

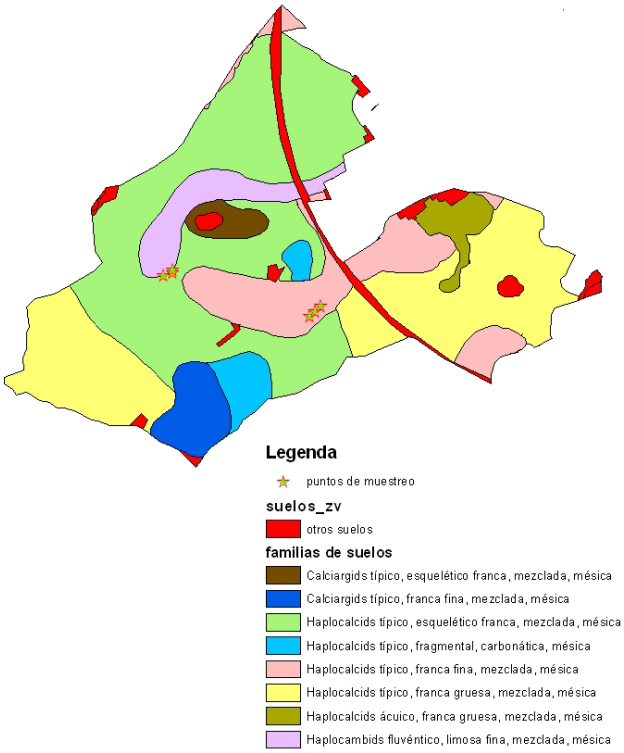

Figure 1. Soil map of the Vulnerable Zone (based on the soil map 1:20.000 edited by la Comunidad Autónoma de La Rioja)

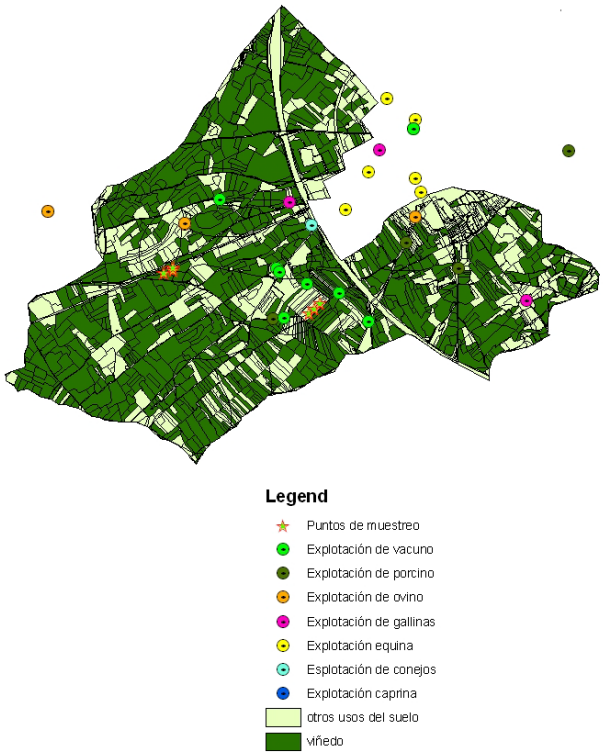

Figure 2. Use soil map and location of livestock farms on the VZ (based on information from SIGPAC)