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Comparison of policies for controlling groundwater nitrate pollution from agriculture in the Eastern Mancha aquifer (Spain).

S. Peña-Haro (1), C. Llopis-Albert (2), M. Pulido-Velazquez (3), A. Stalder (1), A. Garcia-Prats (3), and L. Henriquez-Dole (3)

(1) Institute of Environmental Engineering, ETH Zürich, Switzerland (pena@ifu.baug.ethz.ch), (2) Instituto Geológico y Minero de España (IGME), Valencia, Spain, (3) Research Institute of Water and Environmental Engineering, Universitat Politècnica de València, Spain

Groundwater nitrate pollution from agriculture has given rise to different legal frameworks. The European Water Framework Directive (WFD) is the most recent one. This work aims to help in the definition of the most cost-efficient policy to control non-point groundwater to attain the objectives established in the WFD.

In this study we performed a cost-effectiveness analysis of different policies for controlling groundwater nitrate pollution from agriculture. The policies considered were taxes on nitrogen fertilizers, water price, taxes on emissions and fertilizer standards. We used a hydro-economic model, where we maximized the farmer's benefits. The benefits were calculated as sum of crop revenue minus variable and fixed cost per hectare minus the damage costs from nitrogen leaching. In the cost-effectiveness analysis we considered the costs as the reduction on benefits due to the application of a policy and the effectiveness the reduction on nitrate leaching.

The methodology was applied to Eastern Mancha aquifer in Spain. The aquifer is part of the Júcar River Basin, which was declared as EU Pilot Basin in 2002 for the implementation of the WFD. Over the past 30 years the area has undertaken a significant socioeconomic development, mainly due to the intensive groundwater use for irrigated crops, which has provoked a steady decline of groundwater levels and a reduction of groundwater discharged into the Júcar River, as well as nitrate concentrations higher than those allowed by the WFD at certain locations (above 100 mg/l.).

Crop revenue was calculated using production functions and the amount of nitrate leached was estimated by calibrated leaching functions. These functions were obtained by using an agronomic model (a GIS version of EPIC, GEPIC), and they depend on the water and the fertilizer use. The Eastern Mancha System was divided into zones of homogeneous crop production and nitrate leaching properties. Given the different soil types and climatic influences in the study area, spatially different responses of crop growth and nitrate leaching were obtained and different management areas were defined.

The efficiency of the policies were measured in terms of reduction in nitrate leaching; however, is of interest to estimate the influence of the reduce nitrate leaching on the groundwater nitrate concentration. Furthermore, we introduced the nitrate leaching results from the different scenarios into a flow a transport model, in order to relate the nitrate leaching reduction with its influence upon nitrate concentrations in groundwater. The results show that fertilizer taxes are the most cost-effective measure.

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