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Understanding the differences in nitrate-nitrogen concentration and yield of two rainfed winter cereal watersheds in Navarre (Spain)

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Rainfed winter cereal is the most extended agricultural land use around the world, representing ca. 20% of the cultivated area. As is well known, synthetic fertilizers are widely used to maintain the required levels of food production for a growing population. However, fertilizers may generate a deterioration of water quality in both surface and groundwater bodies. Particularly, N fertilization and associated nitrate leaching is recognized as of paramount importance in the deterioration of water quality.
In Navarre (Spain), nitrate pollution is a relevant problem in water bodies. For that reason, the former Department of Agriculture, Livestock and Food of the Government of Navarre implemented a network of experimental watersheds in order to provide data for assessing the effect of agricultural activity on erosion and water quality. Two of the watersheds included in this network, namely La Tejería and Latxaga, represent rainfed winter cereal land use. These watersheds present rather similar climate (humid sub-Mediterranean, 750-850 mm of annual rainfall and 12 ºC of average annual temperature) and soils (silty clay loams, ≈2% of organic matter). Both are under the typical agricultural management in Navarre, but present subtle differences. For instance, fertilization rates and productivities in Latxaga are slightly higher than those in La Tejería.
Despite the similar characteristics in both watersheds, during the last twenty years, median nitrate concentration in La Tejería has been approximately four times that of Latxaga (ca. 80 mg L-1 and 20 mg L-1, respectively). To a lesser degree, a similar pattern has been observed in nitrate-nitrogen yield with La Tejería exporting almost twice as much N as Latxaga (ca. 35 and 20 kg ha-1 year-1, respectively). Several factors, both of natural and anthropogenic origin, may contribute to explain these unexpected differences. For instance, slope shape, stream sinuosity or artificial drainage influence the residence time of water (and nitrate) in the watershed, modifying the contact time with soils, riparian areas, etc. and therefore allow for higher retention within the watershed. In addition, differences in the vegetation communities in riparian areas or the landscape fragmentation are other feasible controlling factors.
In this study, we aim to improve the knowledge of the nitrate-nitrogen dynamics in rainfed agricultural watersheds and, particularly, the factors that may explain the differences observed between two similarly managed watersheds in Navarre.