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Using agricultural practices information for multiscale environmental assessment of phosphorus risk

Mariana Matos Moreira (1,2,3), Blandine Lemercier (1,2,3), Didier Michot (1,2,3), Rémi Dupas (1,2,3), Chantal Gascuel-Odoux (2,1,3)

(1) AGROCAMPUS OUEST, UMR 1069 SAS, F-35042 Rennes, France (mariana.moreira@agrocampus-ouest.fr), (2) INRA, UMR1069 SAS, F-35042 Rennes, France, (3) Université européenne de Bretagne, France

Phosphorus (P) is an essential nutrient for plant growth. In intensively farmed areas, excessive applications of animal manure and mineral P fertilizers to soils have raised both economic and ecological concerns. P accumulation in agricultural soils leads to increased P losses to surface waterbodies contributing to eutrophication. Increasing soil P content over time in agricultural soils is often correlated with agricultural practices; in Brittany (NW France), an intensive livestock farming region, soil P content is well correlated with animal density (Lemercier et al.,2008). Thus, a better understanding of the factors controlling P distribution is required to enable environmental assessment of P risk. The aim of this study was to understand spatial distribution of extractable (Olsen method) and total P contents and its controlling factors at the catchment scale in order to predict P contents at regional scale (Brittany).

Data on soil morphology, soil tests (including P status, particles size, organic carbon. . .) for 198 punctual positions, crops succession since 20 years, agricultural systems, field and animal manure management were obtained on a well-characterized catchment (ORE Agrhys, 10 km^2). A multivariate analysis with mixed quantitative variables and factors and a digital soil mapping approach were performed to identify variables playing a significant role in soil total and extractable P contents and distribution. Spatial analysis was performed by means of the Cubist model, a decision tree-based algorithm. Different scenarios were assessed, considering various panels of predictive variables: soil data, terrain attributes derived from digital elevation model, gamma-ray spectrometry (from airborne geophysical survey) and agricultural practices information.

In the research catchment, mean extractable and total P content were 140.0 $\pm$ 63.4 mg/kg and 2862.7 $\pm$ 773.0 mg/kg, respectively. Organic and mineral P inputs, P balance, soil pH, and Al contents were positively correlated with soil P contents. Also land use, crop rotation and livestock production system influenced P contents. The highest mean values of P were found in croplands and close to pig farms. The lowest mean values of P were found in pastures and nearby dairy farms. The spatial analysis showed that sand content, geophysical parameters and P input by organic fertilization were the most significant variables for the linear predictive model of extractable P contents. For total P, geophysical parameters and P balance had the highest importance for the respective linear predictive model.

This study revealed that agricultural practices information plays a significant role in soil P distribution. Once controlling factors of P spatial distribution were identified, relationships could be extrapolated at regional scale using the National Soil Test Database providing information on extractable P content and available information on agricultural practices in order to improve predictions of total P content at regional scale.

Lemercier B., Gaudin, L., Walter C., Aurousseau P., Arrouays D., Schvartz C., Saby N., Follain S., Abrassart J., 2008. Soil phosphorus monitoring at the regional level by means of a soil test database. Soil Use and Management, 24, 131-138.