Comprehensive characterization of agricultural proximity to surface water in France

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1. Introduction

Regulatory exposure modeling for pesticides relies heavily on hypothetical scenarios to accommodate landscape variability across large extents. Proximity is an important factor to potential aquatic exposure from agricultural application of pesticides. Characterizing proximity 'in total', as opposed to selected locations, allows for reduced uncertainty regarding this aspect of off-field pesticide transport. The availability of high spatial and temporal resolution cropping and hydrographic data in France provides an opportunity to characterize agricultural proximity across the country and discern regional or more local variations.

2. Materials and methods

The Registre parcellaire graphique (RPG) from Institut National de l'Information Géographique et Forestière (IGN) represent individual agricultural plots used as a reference for the Common Agricultural Policy (CAP) and contain 9.4 million parcels in mainland France. RPG contains over 325 individual culture codes and over 807,000 parcels encompassing 2,825,326 ha of maize (culture code group 2 "Maïs grain et ensilage") in 2017. BD TOPO® Version 3.0 was obtained from IGN and contained over 2.7 million linear water features (e.g., streams, narrow rivers) and 930,000 area water features (e.g., wide rivers, lakes, ponds) utilized for this study.

Proximity distances of 20, 30, 50 and 60m were assessed from all surface water features and intersected with maize parcels. Three methods of analysis were implemented to determine the total area of maize parcels potentially impacted (i.e., area of maize potentially impacting surface water) with these distances.

- In the **Binary Method**, if any portion of the maize parcel is within the proximity distance, the entire maize parcel area is considered "impacted" (Figure 1A). The Binary Method could be considered the most conservative since the entire parcel is considered impacted, regardless of what fraction is actually within the proximity distance.
- The **Buffer Method** considers only the portion of the maize parcel that directly overlaps the proximity distance to be impacted (Figure 1B). The Buffer Method could be considered the least conservative since only the direct overlap area is considered impacted.
- The **Threshold Method** can be considered a dynamic hybrid between the Binary Method and the Buffer Method. In the Threshold Method, if a specified percentage of the maize parcel falls inside the proximity distance (i.e., the 'threshold'), the entire parcel is considered impacted (i.e., the Binary Method). Otherwise, only the direct parcel area with the proximity distance is considered impacted (i.e., the Buffer Method). (Figure 1C, D)

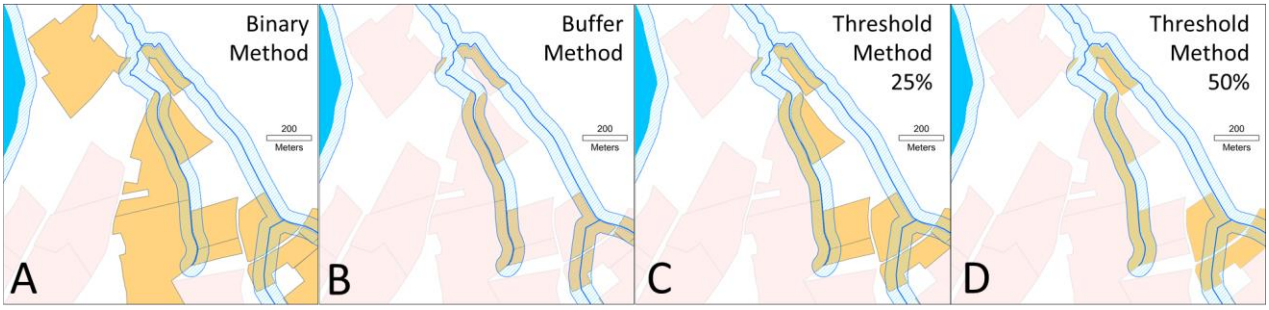

Figure 1: Three approaches with a 50m proximity distance (blue shaded) showing maize area impacted (orange shaded) from Binary Method (A), Buffer Method (B) and Threshold Method with 25% (C) and 50% (D) thresholds.

3. Results and discussion

A plot of the Binary Method results shows the relationship between distance to surface water (x-axis) and percentage of total maize impacted. For example, 46% of maize area has at least some portion of the parcel within 30m of surface water in the Binary Method (Figure 2, left). The Buffer Method results in 5.2% ot total maize in France within 30m of surface water (Figure 2, right), although there are regional differences.

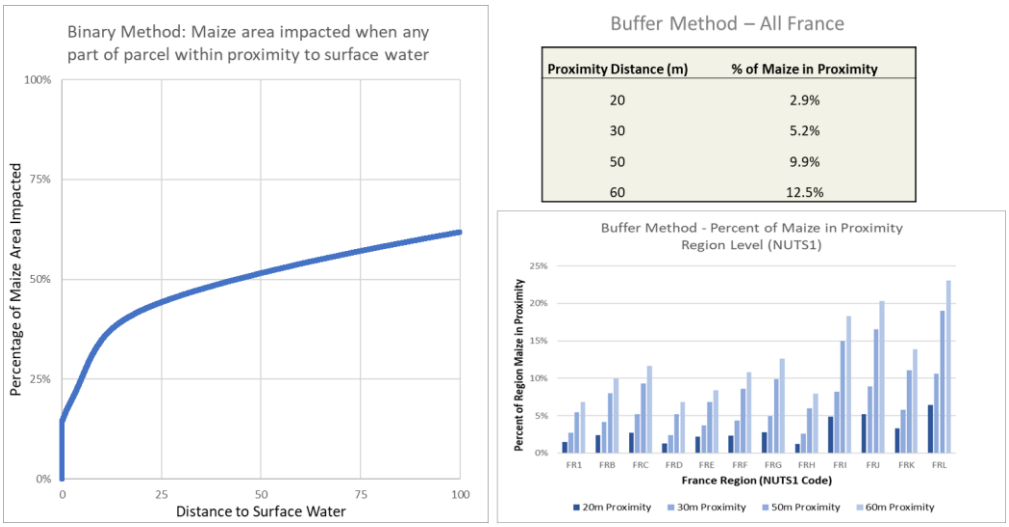

Figure 2: Binary Method for all France (left) and Buffer Method by Region (right)

The Threshold Method results (Figure 3) can be interpreted by proximity distance and threshold percentage. For example, if a 10% threshold is applied to the 50m proximity distance, 31% of the total maize area would be impacted (brown arrows in Figure 3). The Threshold Method chart contains information on all three methods. The Binary Method is equivalent to a threshold of 0% and can be identified on the left side of the chart. The Buffer Method is equivalent to a threshold of 100% and can be identified on the right side of the chart. The Buffer Method is the minimum amount of maize impacted by a specific proximity distance; therefore, the plot does not reach 0% maize impacted at the end of the x-axis. Comparable results can be plotted by units such as Region or Department to assess geographic variation (Figure 3, right).

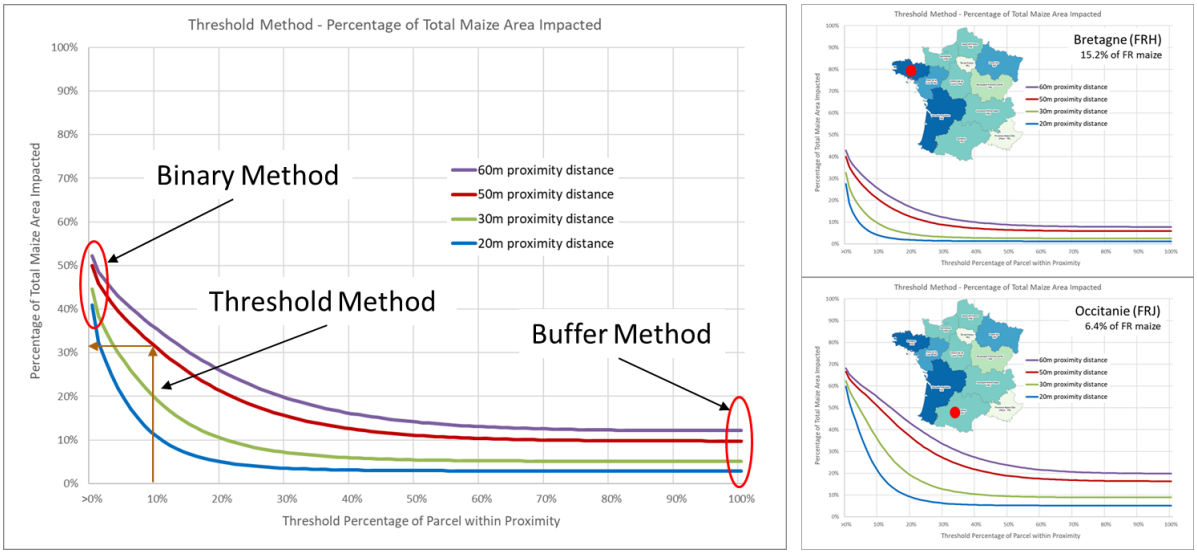

Figure 3: Location of two study areas containing grassland parcels

4. Conclusions

This study demonstrates the viability of parcel-level proximity analyses across mainland France using maize as the target crop. The process has been applied to other crop types and annual time periods. The ability to subgroup results by administrative unit allows for further exploration and initial evaluation of potential drivers in maize proximity. Agricultural parcel proximity to surface water is driven by multiple factors including landscape (e.g., hydrologic conditions, topography, soils, geomorphology) and anthropogenic factors (parcel size and dimensions, grower preferences, historical settlement areas). Further refinements include the ability to determine proximity based on surface water characteristics available in BD TOPO® (e.g., permanent v. intermittent, natural v. artificial, flowing v. static, water body width).