Comprehensive characterization of agricultural proximity to surface water in France

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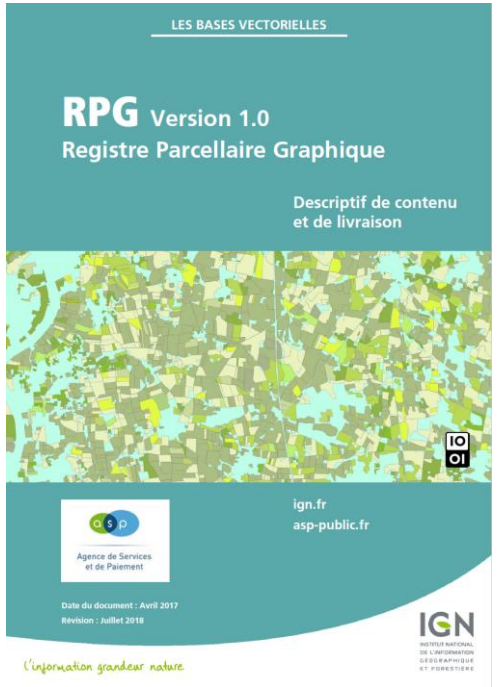
Introduction

- Regulatory exposure modeling for pesticides relies heavily on hypothetical scenarios for landscape variability
- Proximity is an important factor to potential aquatic exposure from agricultural application of pesticides
- Characterizing proximity 'in total' allows for reduced uncertainty regarding off-field pesticide transport
- High resolution cropping and hydrographic data used to characterize agricultural proximity across the country and discern regional variations

Cropping and hydrographic data for France

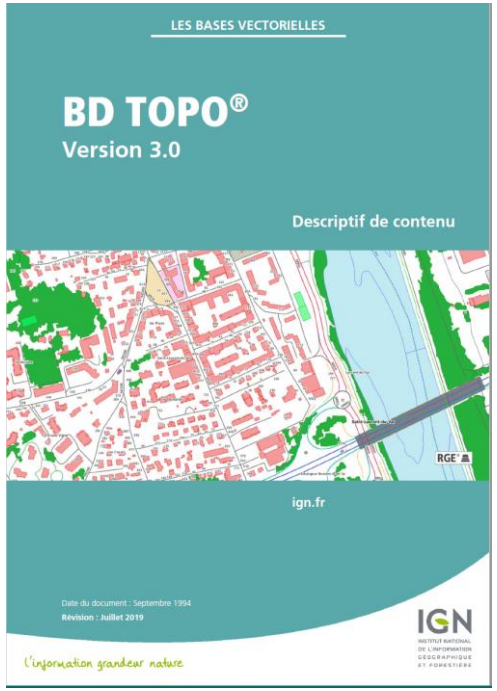
Agricultural parcels

- Registre parcellaire graphique (RPG)
- Developed to support common agricultural policy (CAP)
- 28 crop groups and over 200 individual crops
- 9.4 million parcels
  - 800K parcels – maize
  - 431K parcels - winter cereals (barley, oats, rye, triticale)



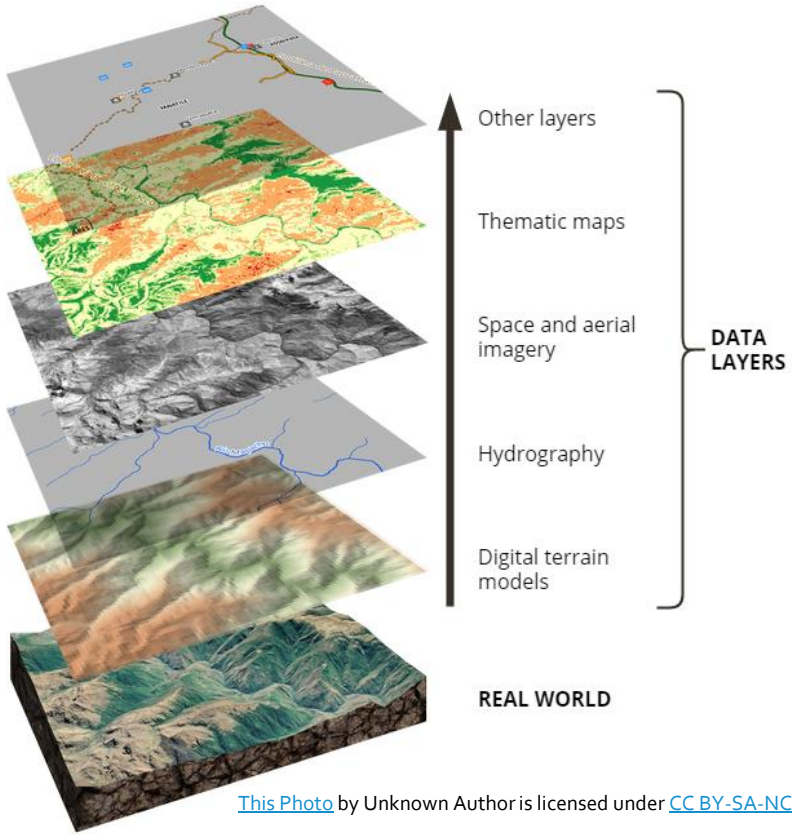
Surface water

- BD TOPO hydrology
- Flowing and static water bodies
- 2.7 million line features
- 0.9 million area features
- Attributes
  - Permanence
  - Nature
  - Size



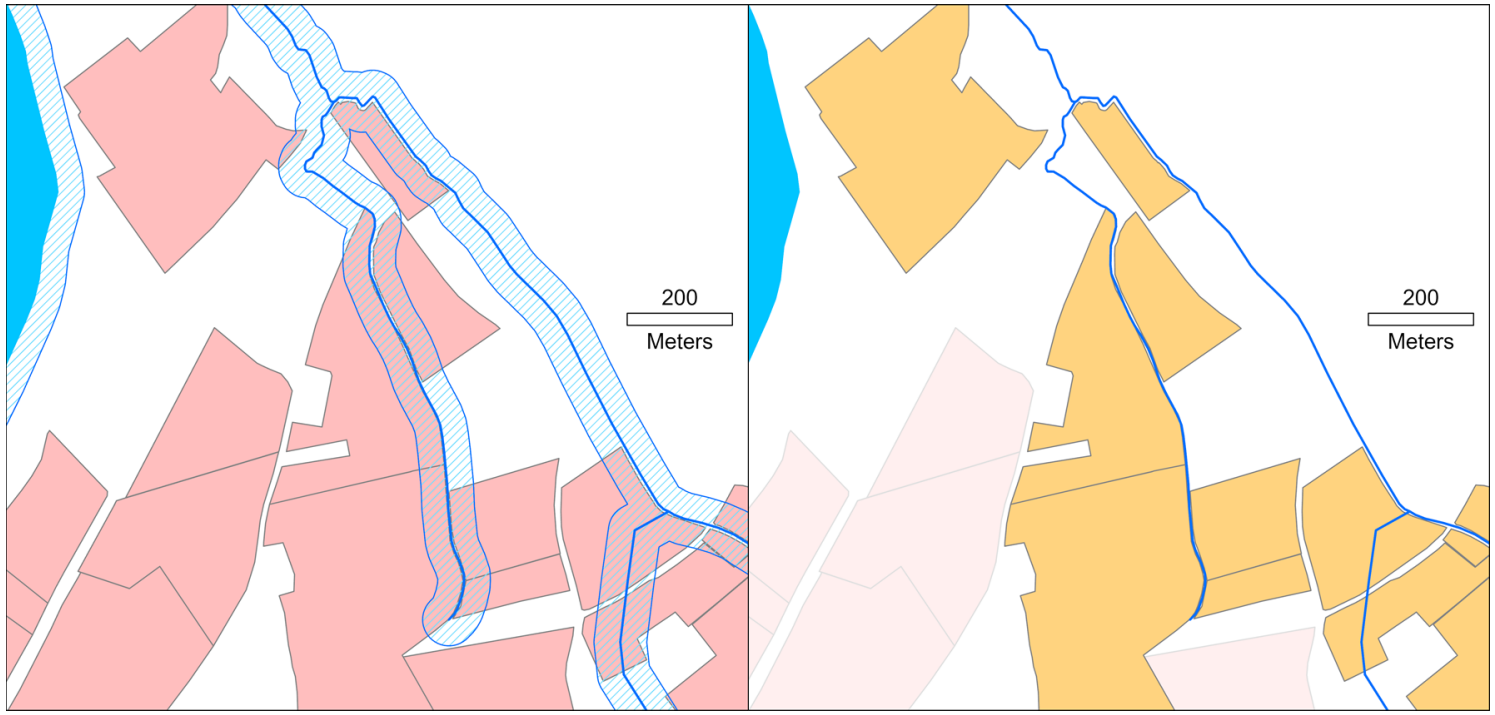
Characterizing proximity to agriculture

- Determine portion of agricultural fields near surface water
  - i.e., the portion of crop that might impact surface water via off-field drift transport
- Distances of interest vary
- Quantitative measurements in Geographic Information Systems (GIS) based on spatial datasets
- Three methods explored to assess proximity



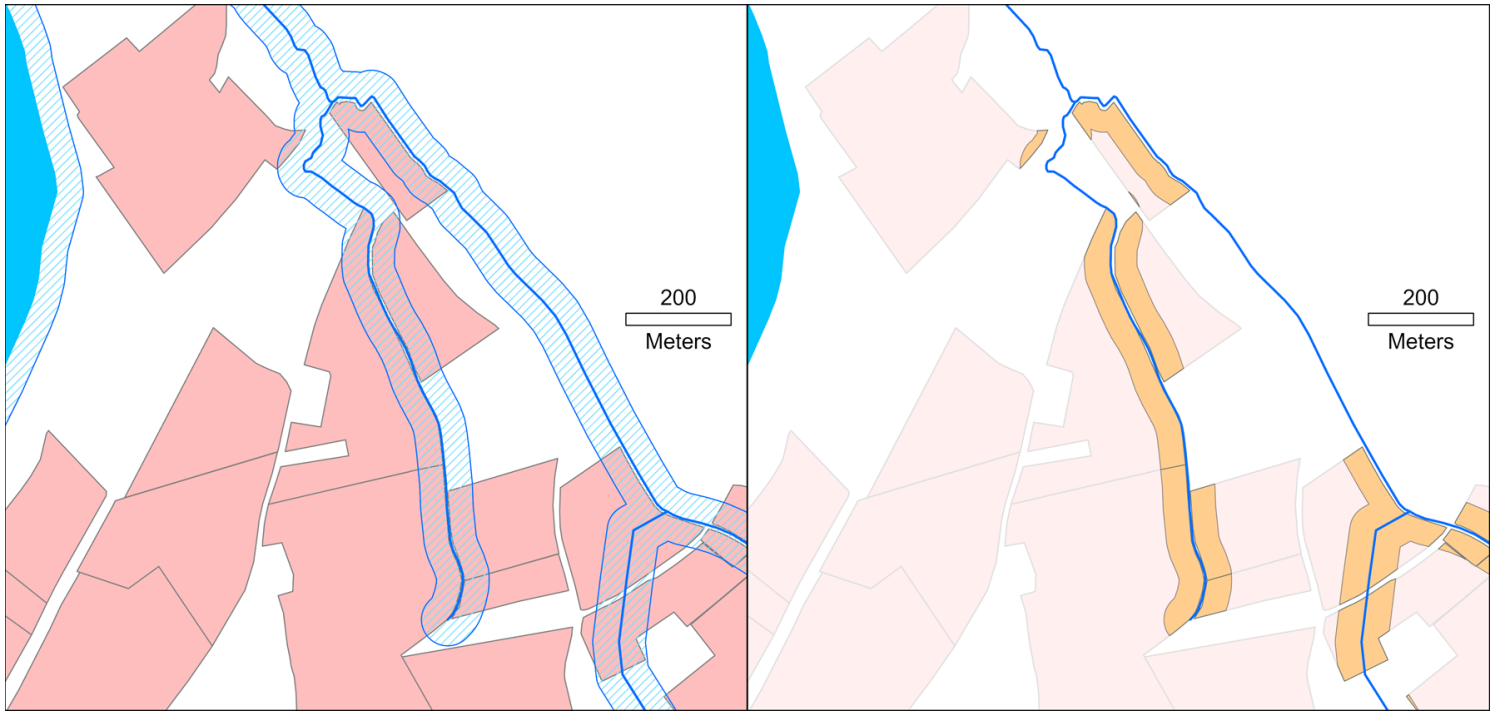
Proximity: Binary Method

- If any portion of the maize parcel is within the proximity distance, the entire maize parcel area is considered "impacted"
- Most conservative since the entire parcel is considered impacted, regardless of what fraction is within the proximity distance



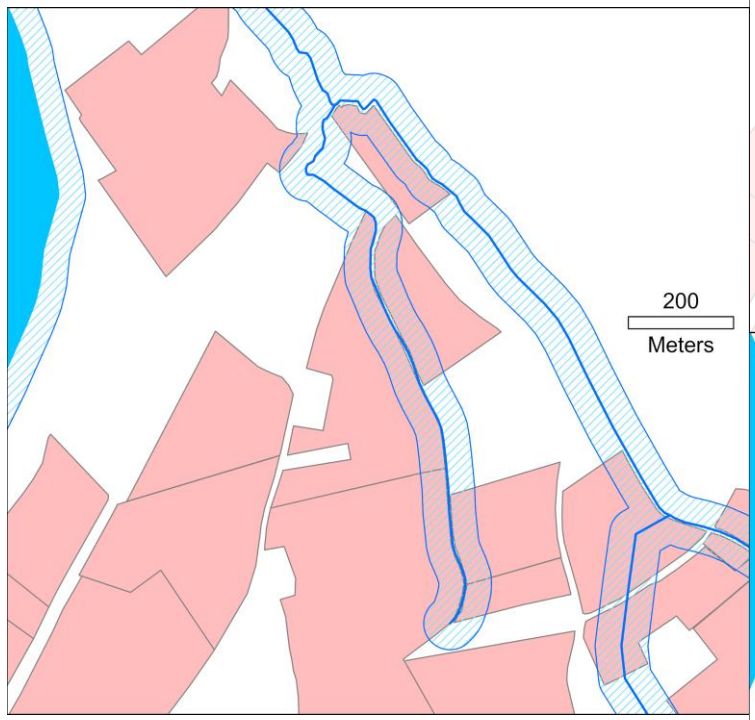
Proximity: Buffer Method

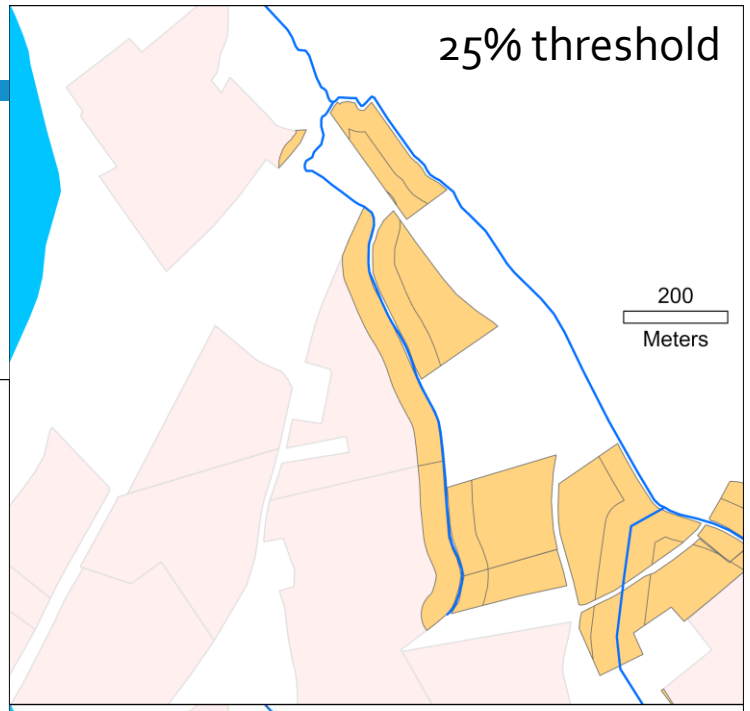
- Only the portion of the maize parcel that directly overlaps the proximity distance is impacted
- Least conservative since only the direct overlap area is considered impacted

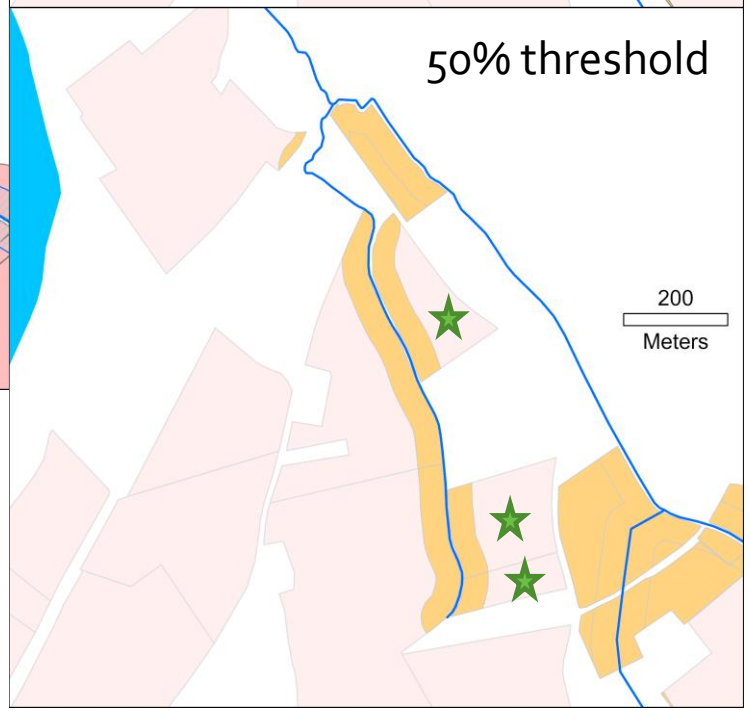


Proximity: Threshold Method

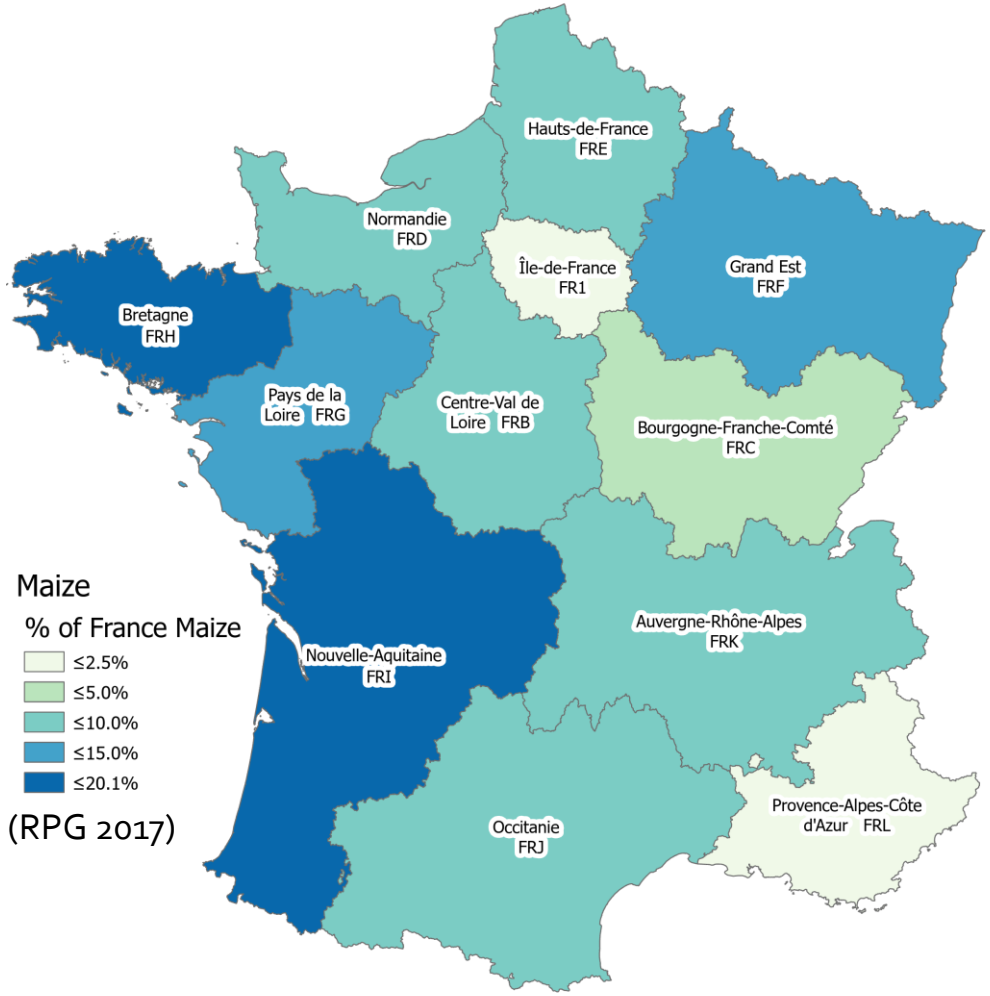
- Hybrid between the Binary and Buffer Method
- If a specified percentage of the maize parcel (i.e., the 'threshold') falls inside the proximity distance, the entire parcel is considered impacted (i.e., Binary Method)
- Otherwise, only the direct parcel area with the proximity distance is considered impacted (i.e., Buffer Method)

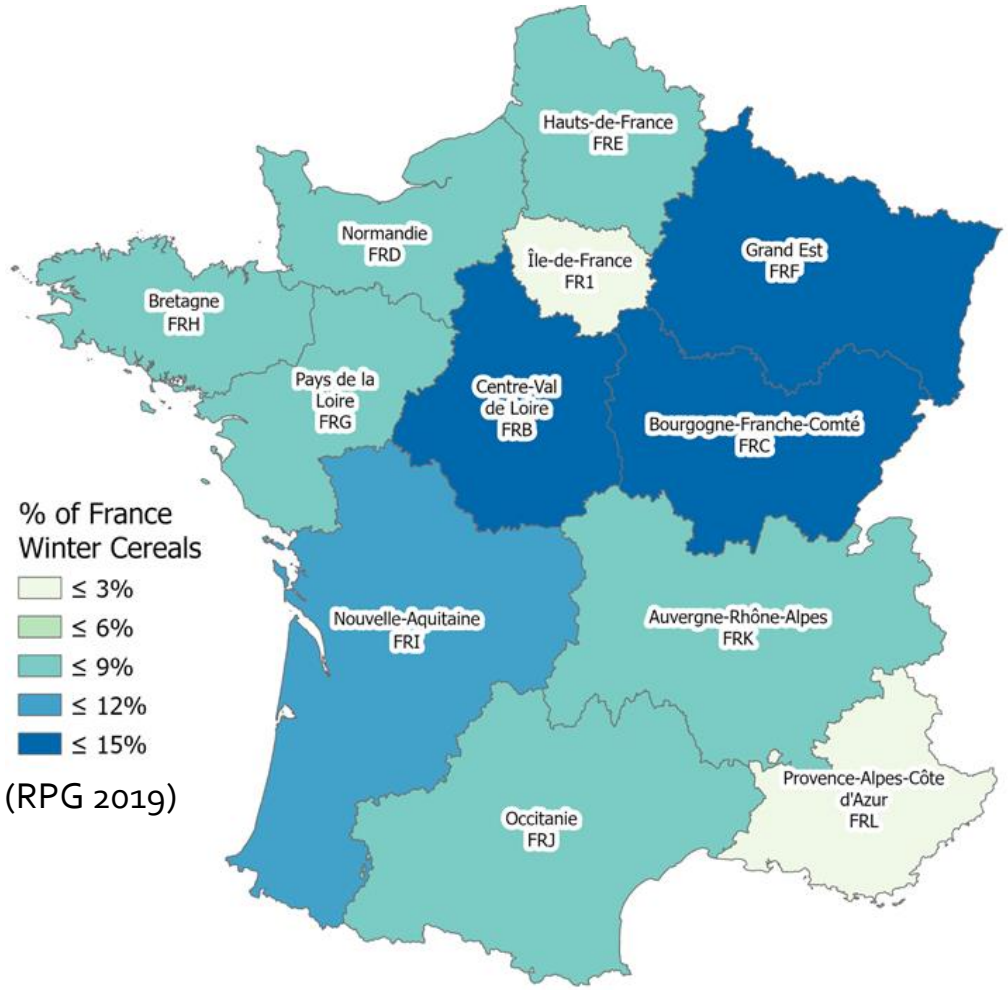




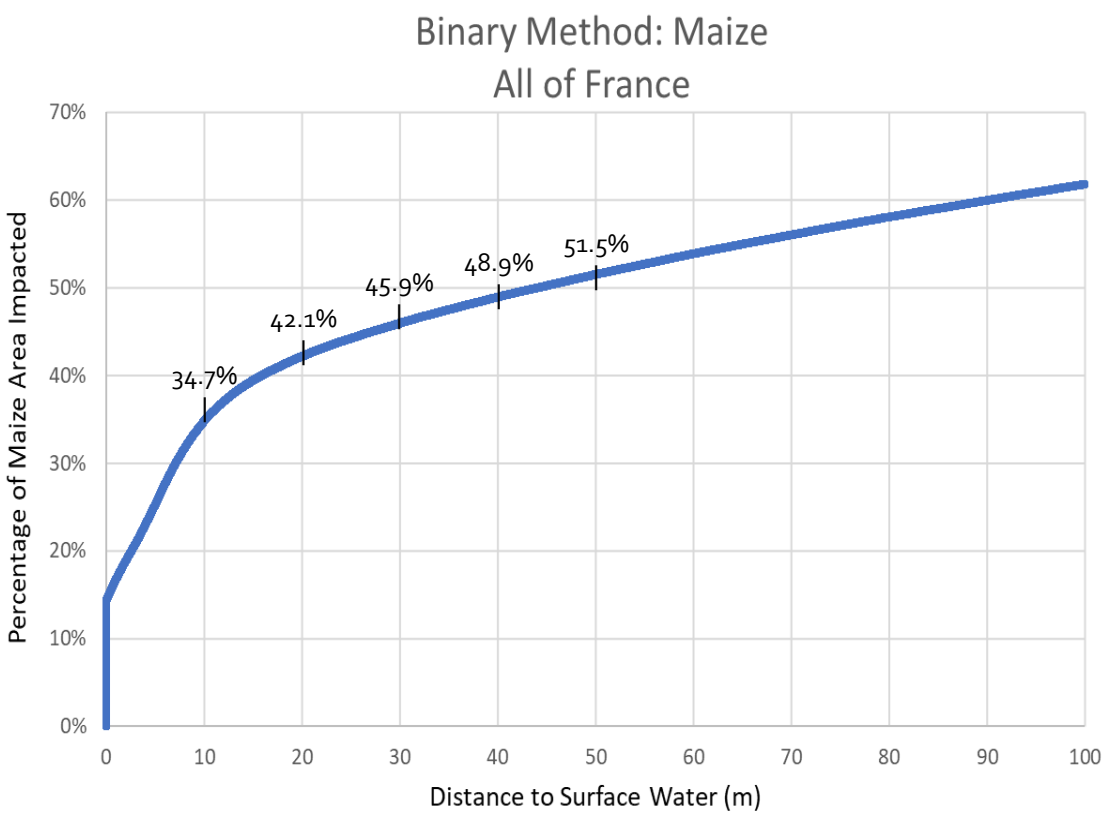


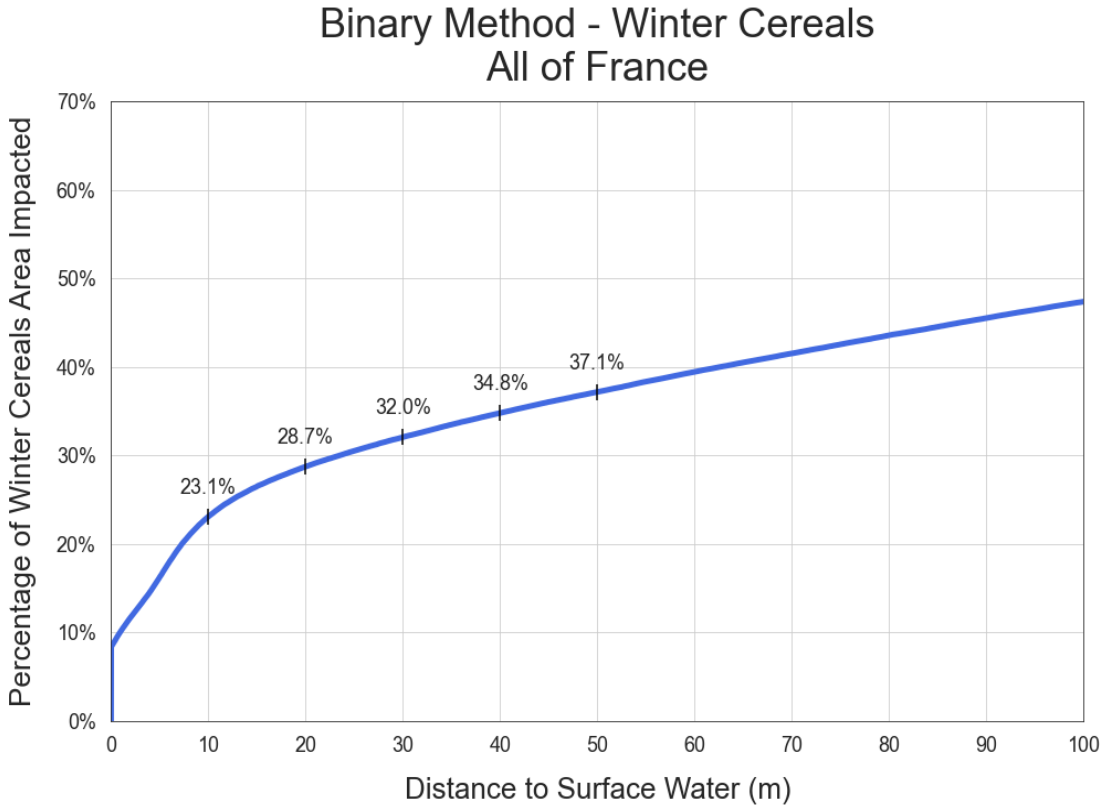
France maize and winter cereals production



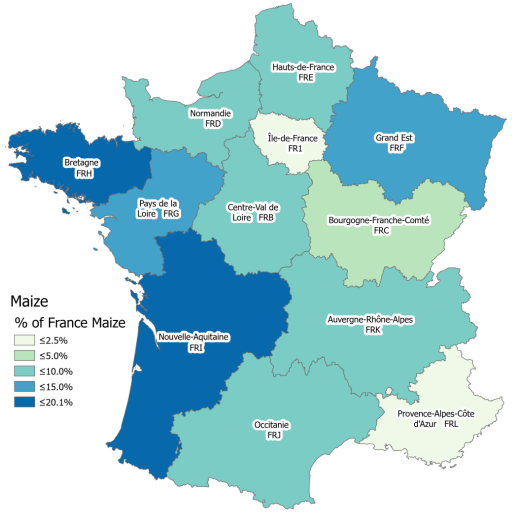


Binary Method results





Buffer Method results

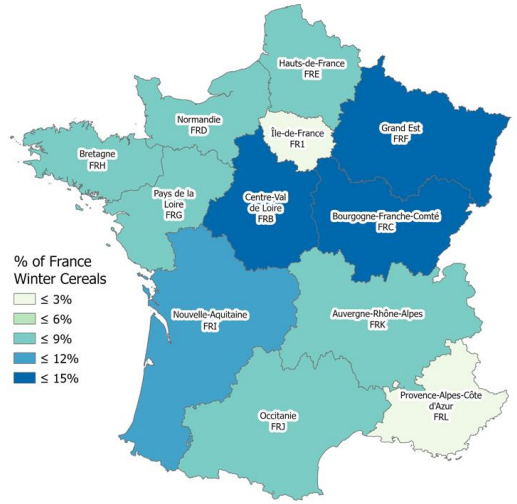


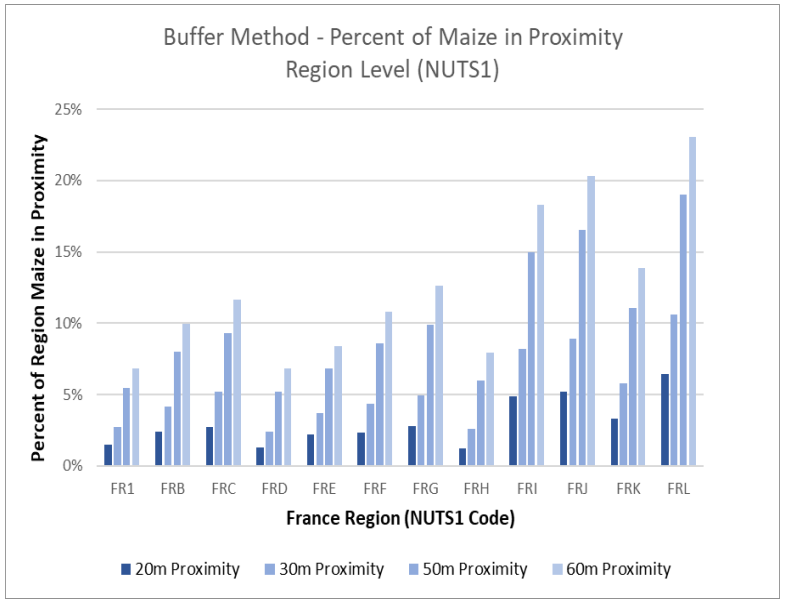
Proximity Distance (m)	Maize in Buffer (ha)	% FR Maize in Buffer
20	82,791	2.9%
30	145,649	5.2%
50	281,003	9.9%
60	352,178	12.5%

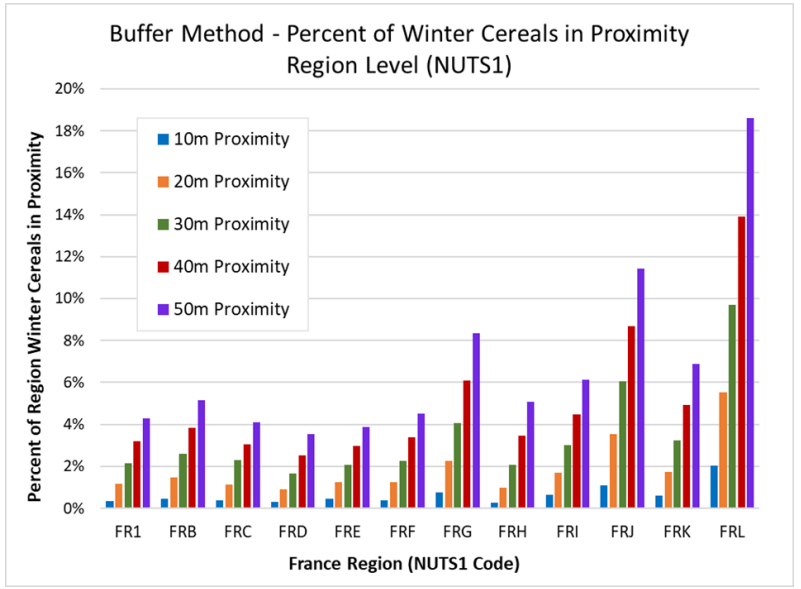
Total maize in RPG: 2,825,326 ha

Proximity Distance (m)	Winter Cereals in Buffer (ha)	% FR Winter Cereals in Buffer
10	8,851	0.5%
20	27,004	1.6%
30	48,690	2.9%
40	71,524	4.3%
50	97,148	5.8%

Total winter cereals in RPG: 1,681,275 ha

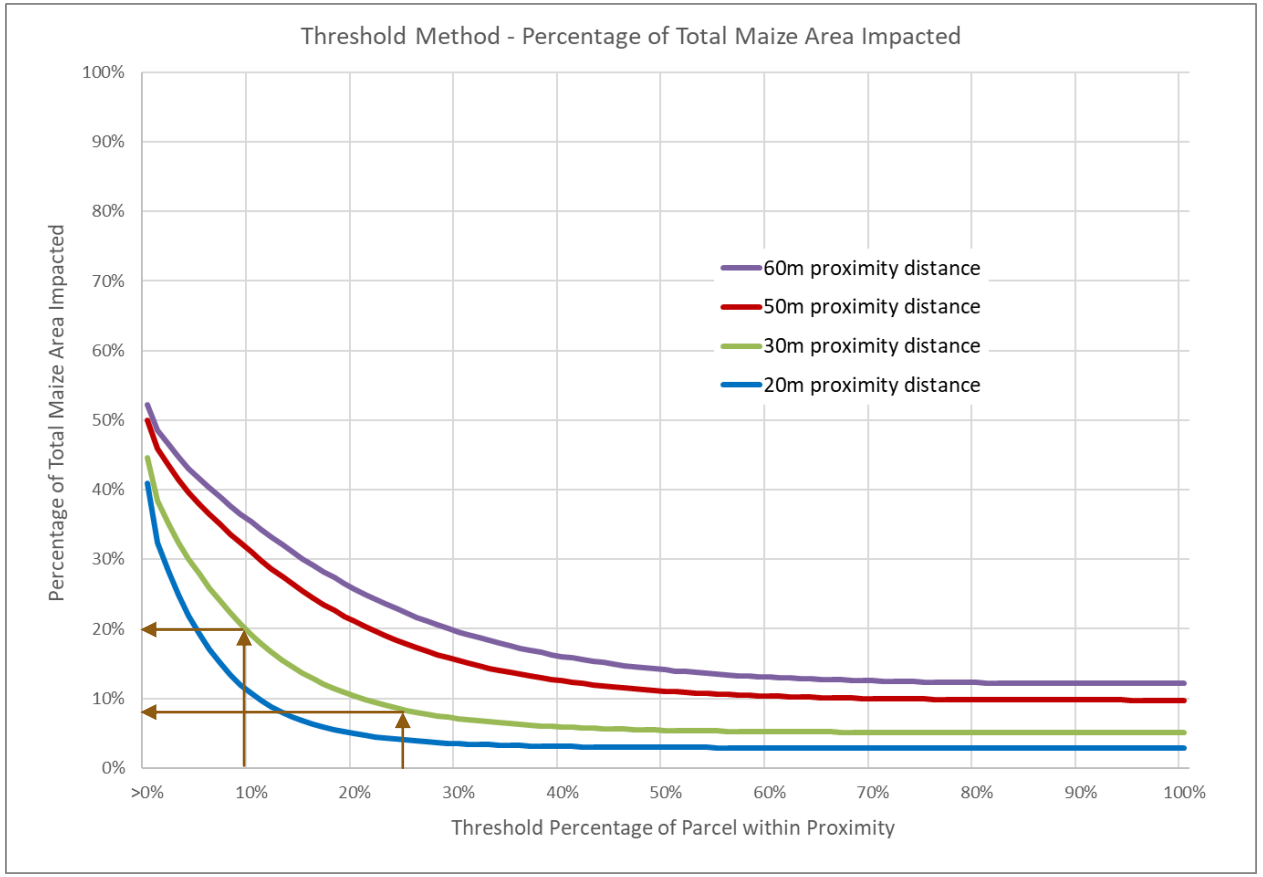






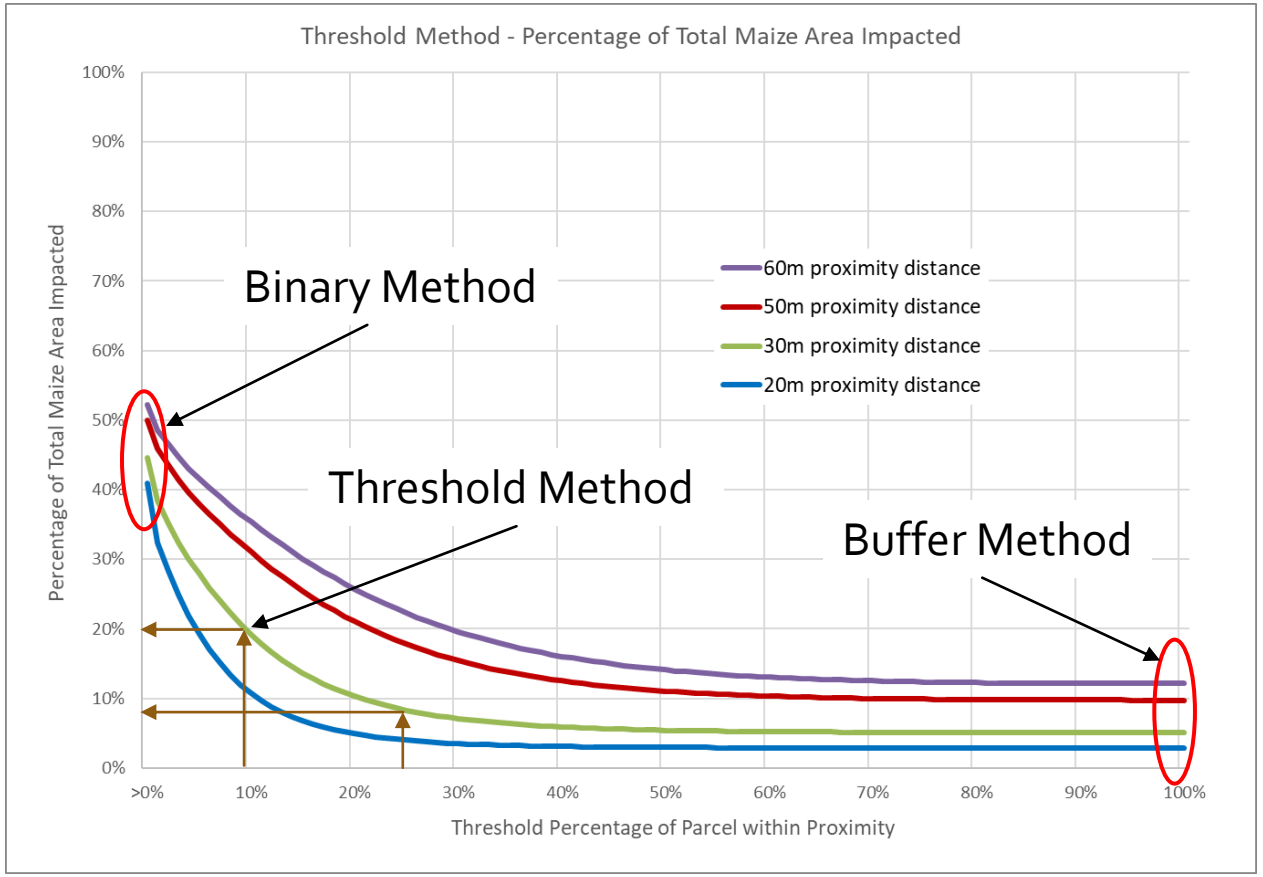
Threshold Method results

- Percentage of crop area impacted based on threshold
- If a 10% threshold is applied to the 30m proximity distance, 20% of the total maize area would be impacted
- If a 25% threshold is applied to the same proximity distance, 8.3% of the total maize area would be impacted

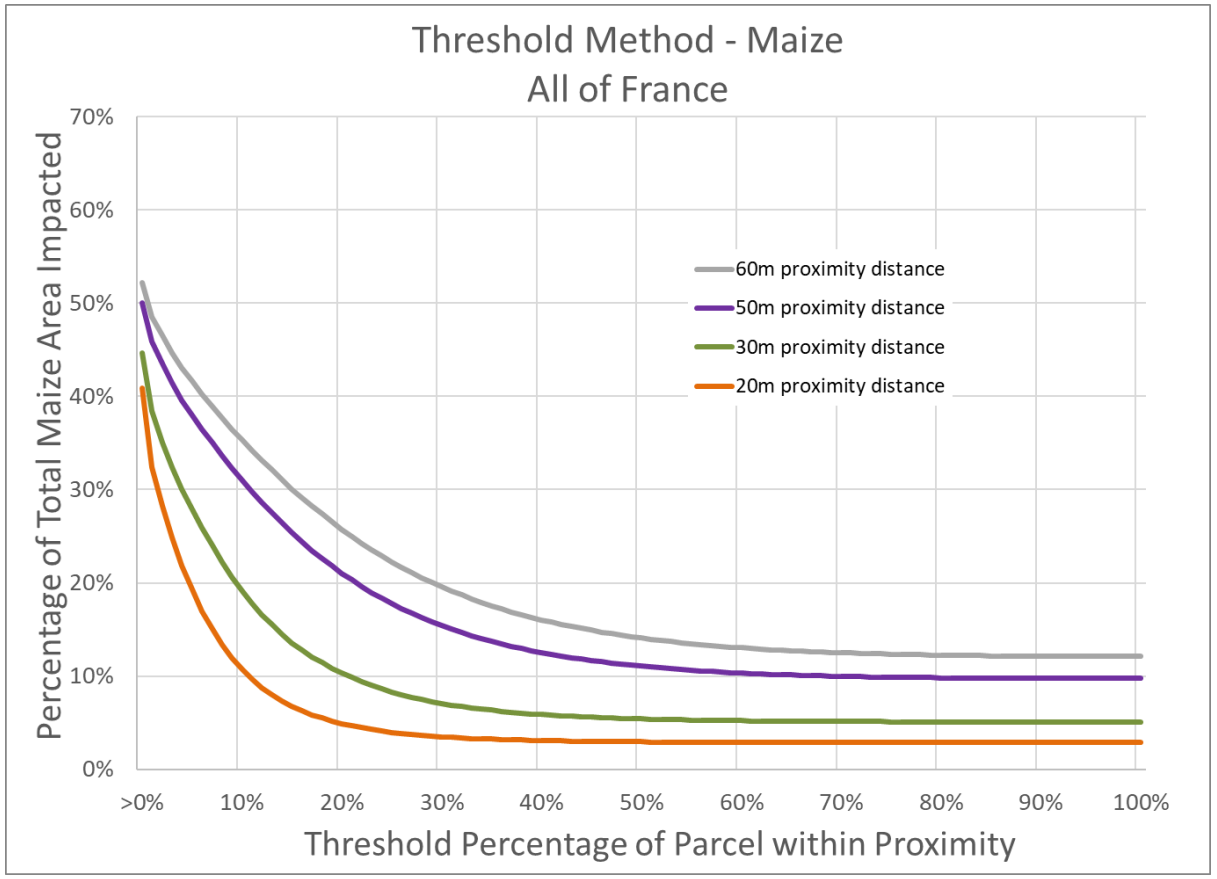


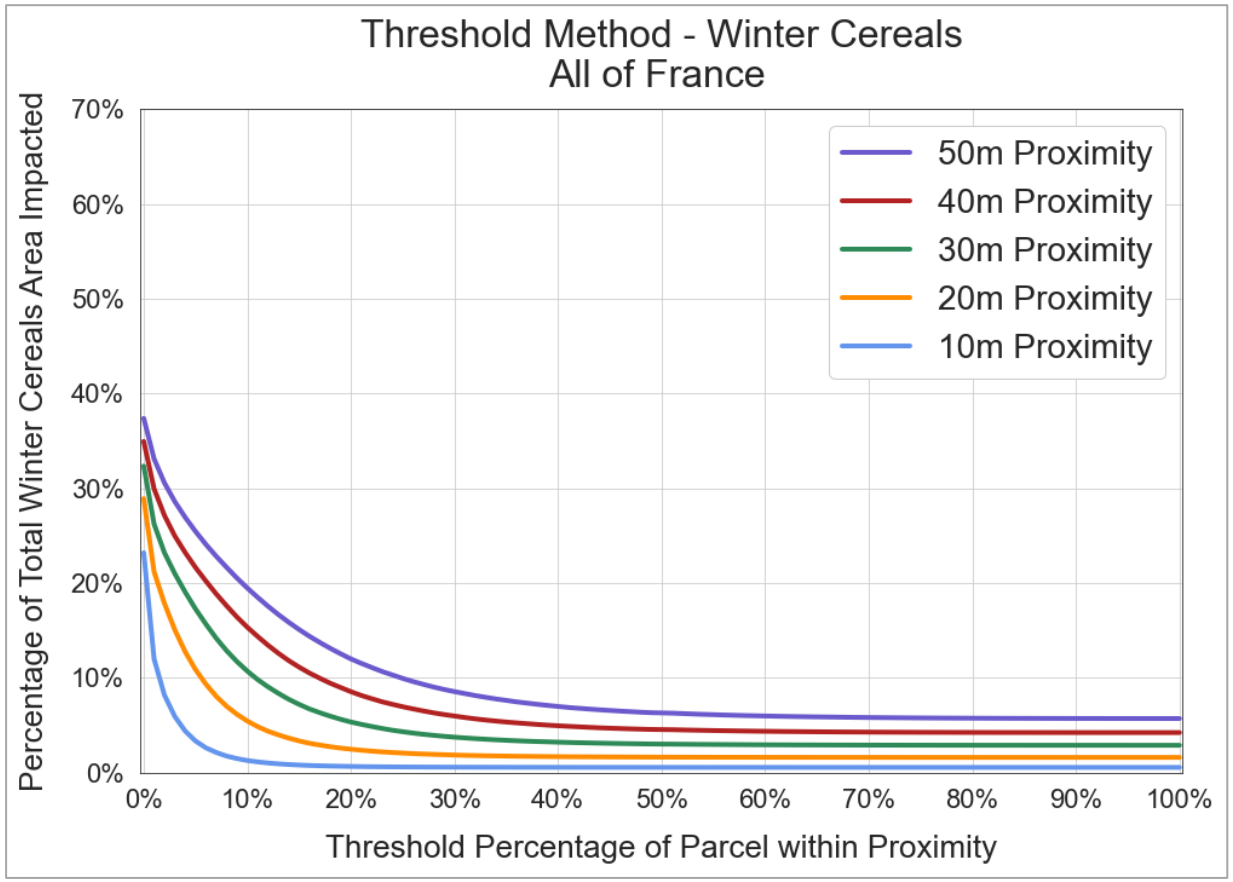
Threshold Method results contains information on all three methods

- The Binary Method is equivalent to a threshold of 0% (i.e., any portion of the parcel within proximity)
  - Left side of the chart (x-axis = 0%)
- The Buffer Method is equivalent to a threshold of 100% (i.e., 100% of the parcel is within proximity)
  - Right side of the chart (x-axis = 100%)
- The Buffer Method is the minimum amount of maize impacted by a specific proximity distance
  - Therefore, the plot does not reach 0% maize impacted on the right side of the x-axis



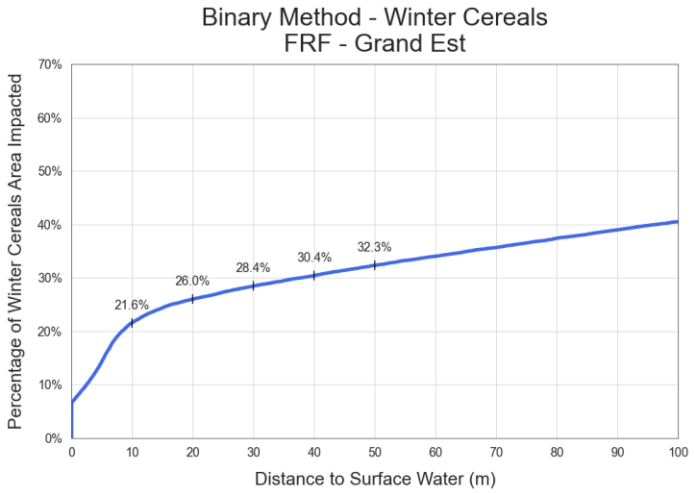
Threshold Method results – compare maize and winter cereals

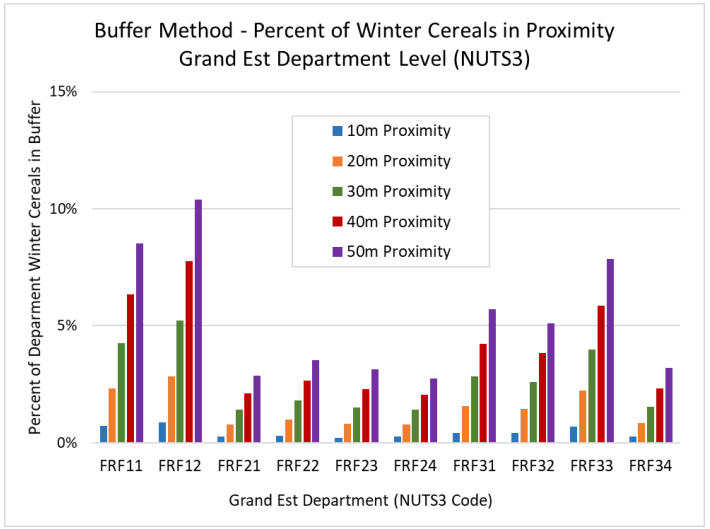


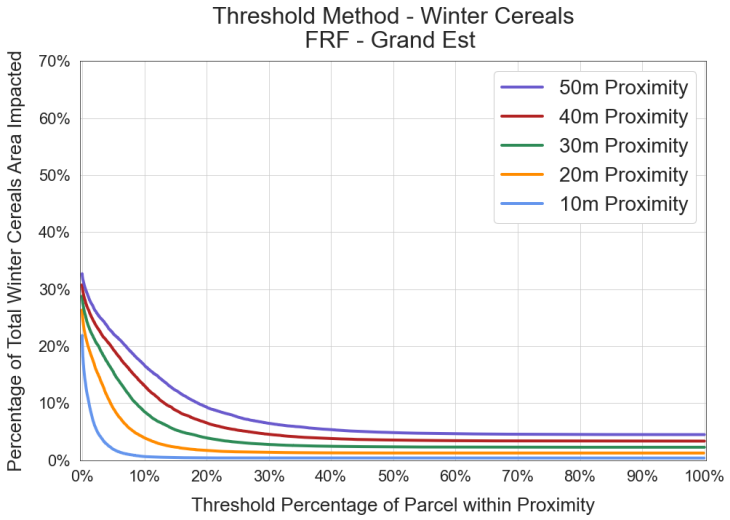


Scalability

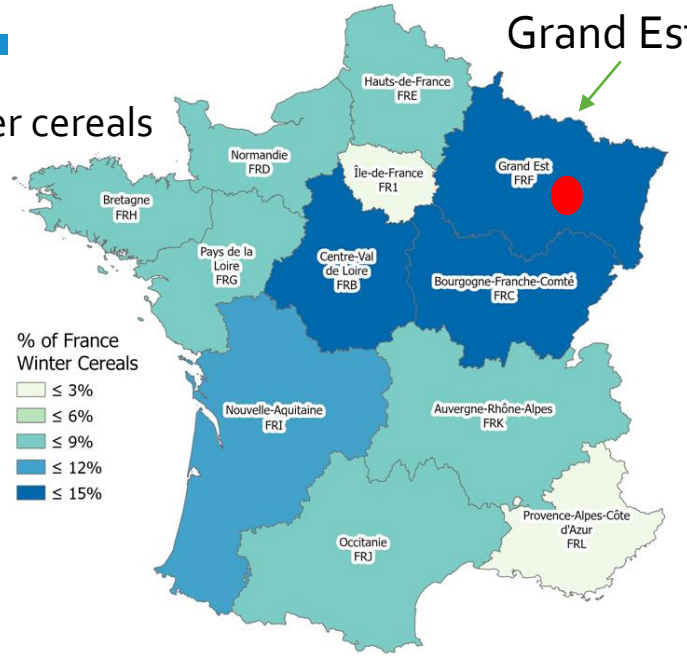
- France : Region : Department
- Crop level
- Surface water type (e.g., only permanent water)



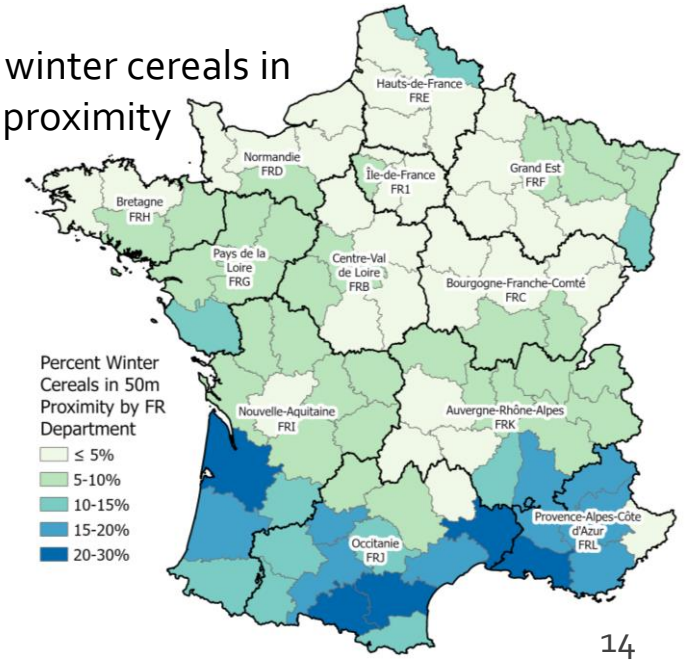




% of FR winter cereals (13.8%)



% of winter cereals in 50m proximity



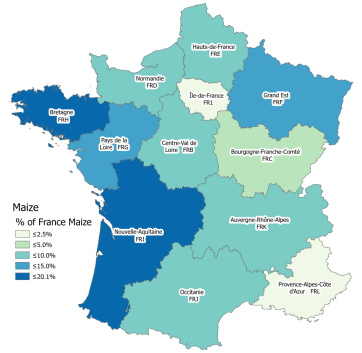
Processing and automation

- Due to limitations in ArcGIS software, processing primarily performed at the Department level
- Automation using models in ArcGIS
  - Chain functions together and iterate through spatial units in a controlled, reproducible and recorded manner
- Five models were implemented to generate raw output
- Python scripts accessed raw model output to summarize and chart results

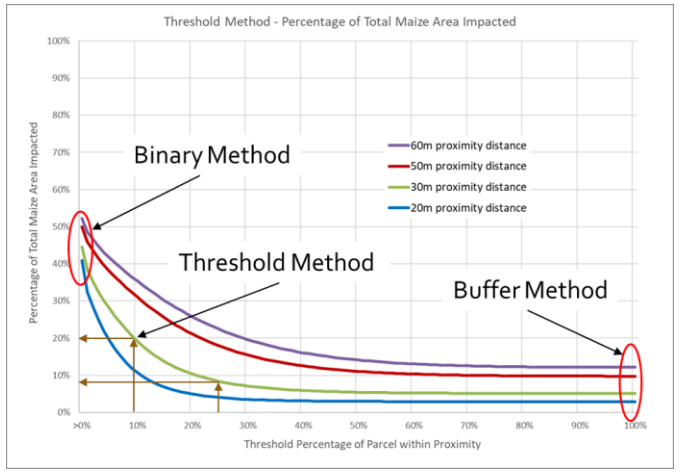

```python
def method3(infile,buff_dist,region):
    print('------------Buffer Distance:'+ buff_dist +'-------------')
    print('------------Region:'+ region +'-------------')
    df_in = pd.read_excel(infile,usecols=['ID_PARCEL','Within_buffer','SUM_Shape_Area',  #read dat
       'SUM_Shape_Area_1','ANY_SURF_PARC','Pct_of_parcel','NUTS3','Buffer'])
    df_in = df_in.sort_values(by = ['Pct_of_parcel'],ascending=False)   #sort dataframe by parcel

    arr_in = df_in.to_numpy() #convert to numpy array
    print('Number of initial records in table:', len(arr_in))
    #row_mask = arr_in[:,1] == 0 | np.logical_and(arr_in[:,1] == 1,arr_in[:,5] == 1)   # create a
    row_mask = arr_in[:,1] == 0    # create a mask to filter out records where "Within_buffer" = 1
    arr_new = arr_in[row_mask,:] # apply row mask to all columns to create new array
    print('Number of records where within_buffer = 0:', len(arr_new))

    A_tot = np.sum(arr_new[:,3])/10000  #calculate total area using SUM_Shape_Area (polygon areas)
    print('Total Parcel Area:', A_tot)

    perc_prox = 1 - arr_new[:,5] #calculate percent of parcel within buffer. subtract pct parcel f
    ha_prox = perc_prox * arr_new[:,4] #calculate area within buffer in ha
    ha_dist = arr_new[:,4] - ha_prox #calculate area outside buffer in ha
    ha_total = arr_new[:,4] #get the total hectares in each parcel
    perc_dist = ha_dist / A_tot #calculate the percentage of total distant crop

    print('Total Parcel Area Within Buffer:', np.sum(ha_prox))
    print('Total Parcel Area Outside Buffer:', np.sum(ha_dist))
```

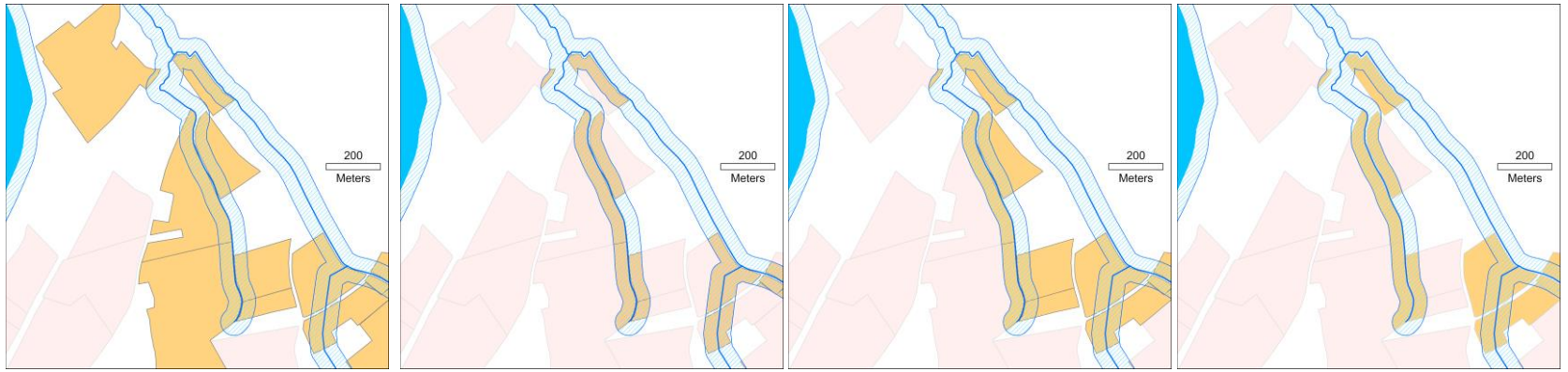
Python scripts

Summary



- This study demonstrates the viability of parcel-level proximity analyses across mainland France
- Applicable to other crop types and time periods
- The ability to subgroup results by administrative unit allows for further exploration and initial evaluation of factors relevant to crop proximity
- Further investigation into parcel proximity to surface water: landscape and anthropogenic factors





Binary Method | Buffer Method | Threshold Method 25% | Threshold Method 50%

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