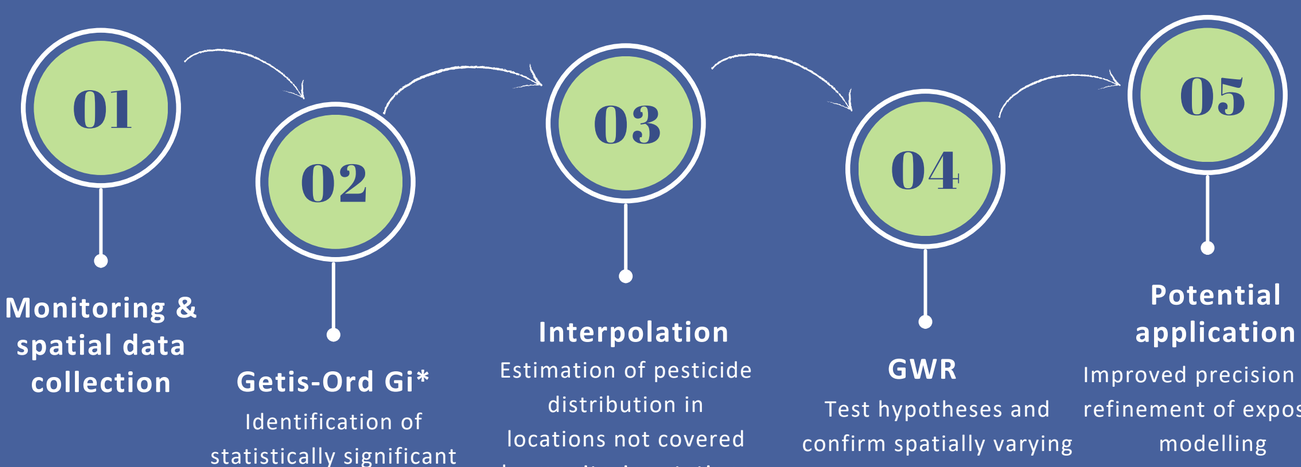
USE OF GEOSPATIAL ANALYSIS TECHNIQUES TO EVALUATE POTENTIAL RISKS OF PLANT PROTECTION PRODUCTS TO DRINKING WATER ABSTRACTION POINTS IN THE NETHERLANDS

CEA
CAMBRIDGE ENVIRONMENTAL ASSESSMENTS

Olha Khomenko[1], Abdul Abu[1]
[1]Cambridge Environmental Assessments (RSK ADAS), Boxworth, Cambridge, UK

Spatially distributed modelling and use of monitoring data are considered higher tiers in the environmental risk assessments of active substances of plant protection products in the EU and Member States.
This case study demonstrates the potential of GIS techniques to identify high-risk areas based on historical survey and monitoring data for an example compound that is applied to potato crops, by confirming spatial relationships between crop production areas and the compound concentration as well as determining the nearest water abstraction area and this location in relation to the pesticide detection hotspots.



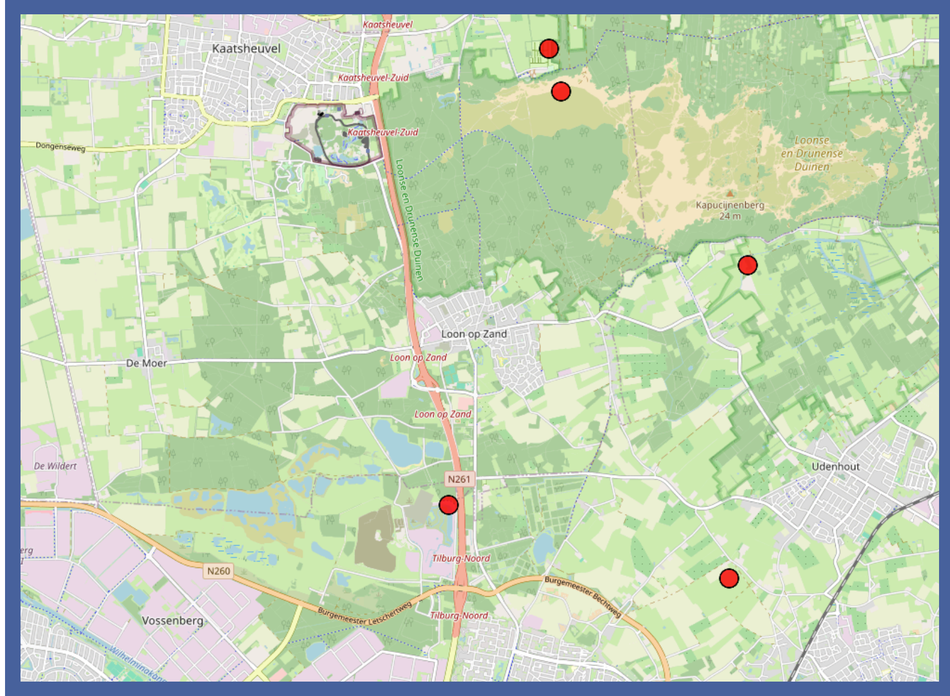


Figure 1: Hotspot analysis of pesticide concentrations exceeding the 0.05 µg/L threshold across the study area (2007-2016).

7 hotspots (99% confidence) were identified. The red circular markers clearly indicate individual hotspot locations within an isolated re.
This distribution suggests that agricultural activities could be the primary contamination source. Given the use of the pesticide for potato crop production the next steps included spatial interpolation to predict additional locations with elevated pesticide levels across the broader region, and implementing Geographically Weighted Regression (GWR) to identify potential correlations between hotspots and specific crop growing fields. This targeted approach will enable agricultural regulatory agencies to develop precise intervention strategies for the most affected areas and implement improved pesticide management practices.

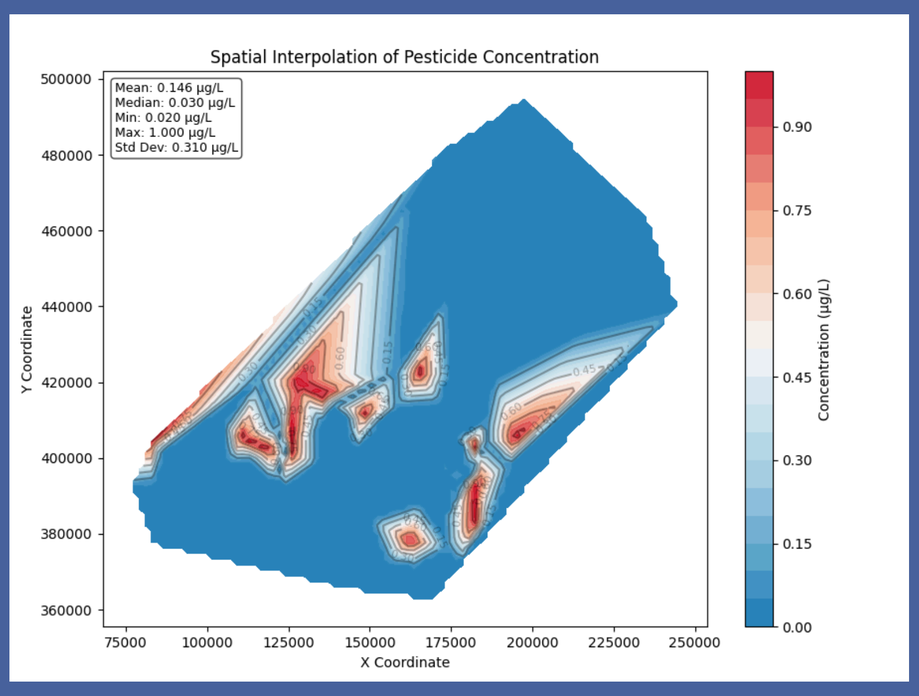
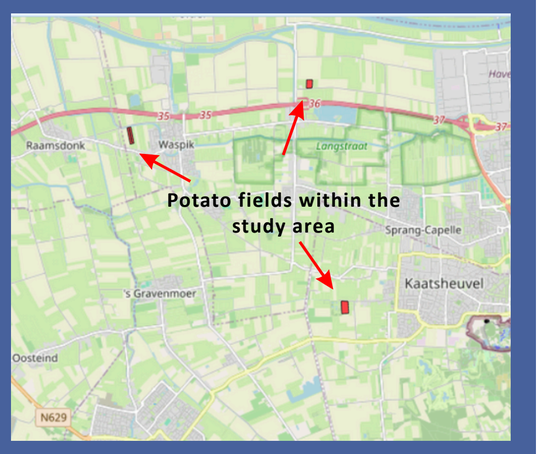
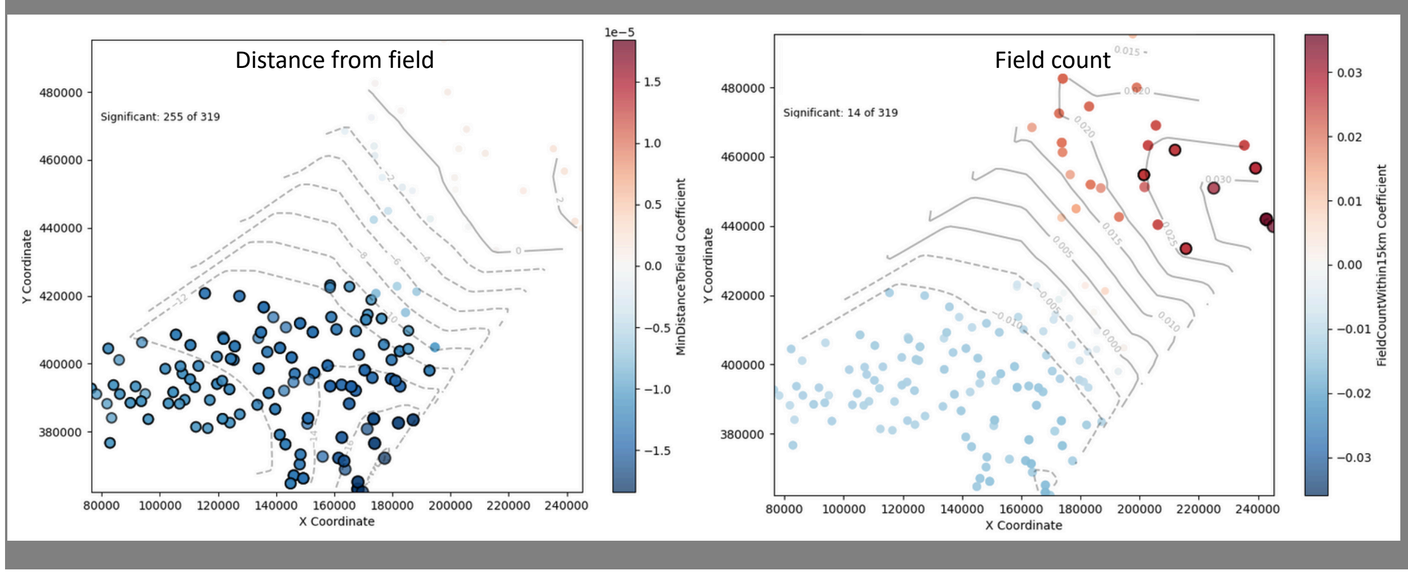


Figure 2: Spatial interpolation of pesticide concentration in groundwater across the study area (2007-2016).

This interpolation map visualizes the predicted spatial distribution of pesticide concentrations across the monitored region. Concentrations range from near-zero (dark blue) to over 1.0 µg/L (dark red), with a mean of 0.146 µg/L and median of 0.030 µg/L.
Several distinct areas with high predicted concentrations are visible in the western and central regions of the study area, where concentrations exceed 0.45 µg/L. The pattern indicate site-specific factors such as land use practices, geology, or flow patterns that concentrate pesticides in particular areas.

The spatial clustering pattern provided the foundation for subsequent geographically weighted regression (GWR) analysis to investigate the relationship between crop growth areas and pesticide detection hotspots. This follow-up analysis was essential for establishing spatial correlation between agricultural land use patterns and detection of the pesticide, allowing to determine whether proximity to specific crop fields is a significant predictor of pesticide concentration as hypothesized. The results inform both regulatory approaches and agricultural management practices aimed at reducing pesticide transport to water resources in vulnerable areas.





- **The GWR analysis reveals strong statistical correlation between distance to fields and pesticide concentrations**
- **Strong negative relationship with pesticide concentrations statistically significant in ~80% of locations**
- **As distance to crop fields decreases, pesticide concentrations increase**
- **Confirms proximity to fields is a reliable predictor of contamination**
- **Field Count and size: Shows limited statistical significance with under 5% of locations showing significant relationships**
- **The relationship between field proximity and pesticide concentrations varies across the study area**
- **GWR allowed detection of localized patterns and has a potential to support standard environmental fate modelling.**

CONCLUSIONS

This approach allowed the capture of spatial variation in the risk associated with water contamination more precisely, allowing for localized assessments that standard regulatory modelling approaches using GeoPEARL, DROPLET, or TOXSWA might overlook. Hot Spot Analysis using the Getis-Ord Gi* technique was employed to identify agricultural areas where potato cultivation posed a statistically significant risk to drinking water abstraction points. These tools helped identify at-risk abstraction points with greater accuracy, confirming that the nearest abstraction point was outside the at-risk area. This method allows for the refinement of environmental risk assessments with high precision, taking into account the local context.