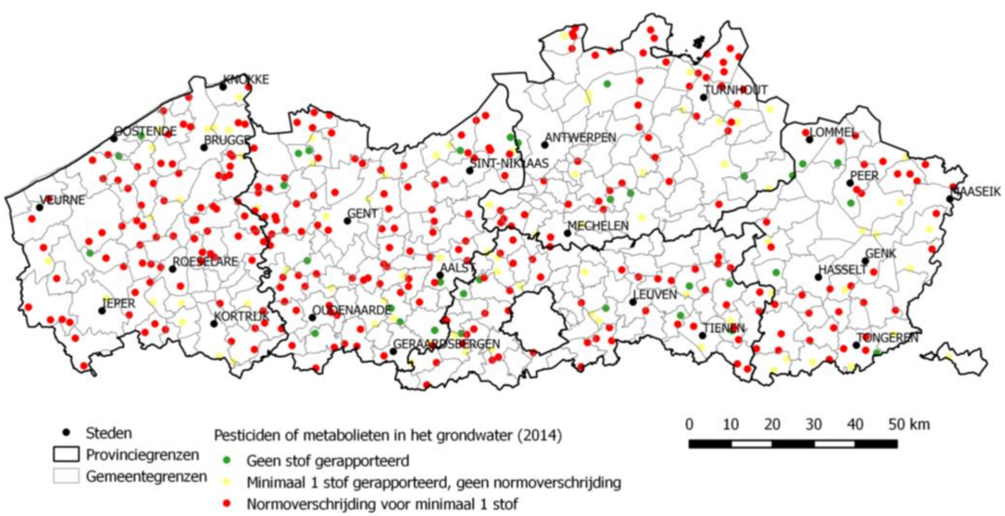
vito

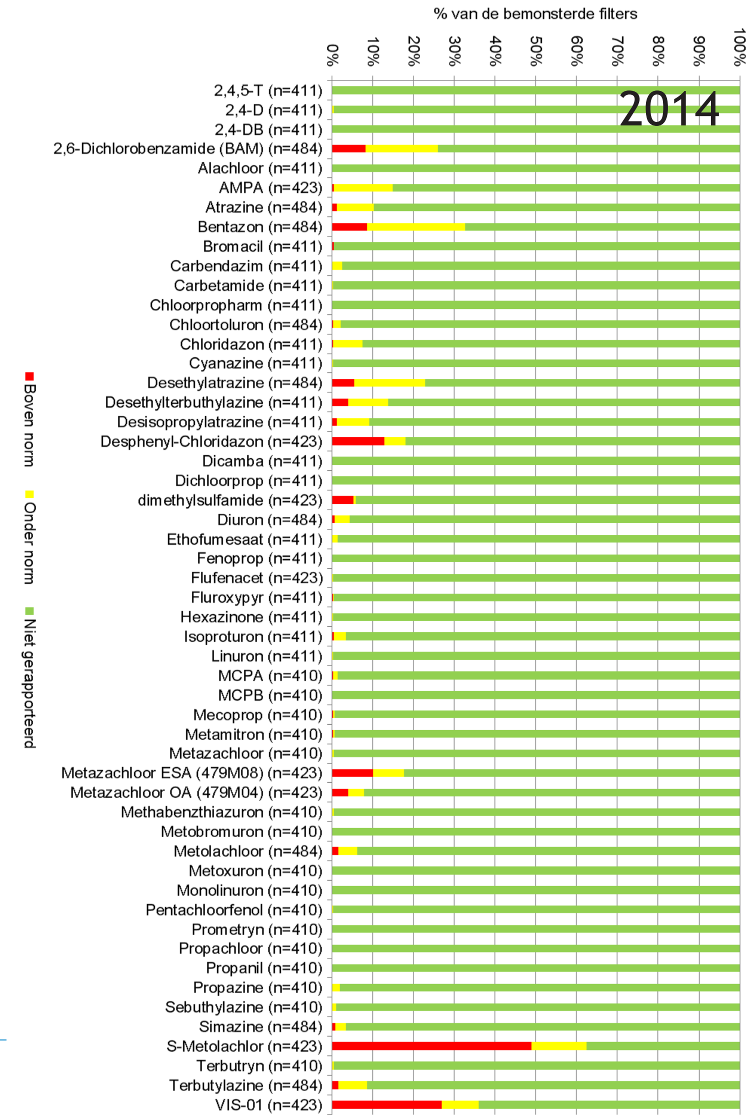
CAN VULNERABILITY MAPS EXPLAIN PESTICIDE FINDINGS IN GROUNDWATER?

Ingeborg Joris, Jef Dams, Johan Patyn, Jan Bronders

BACKGROUND

- » Frequent detects of PPPs and metabolites in (shallow) groundwater
- » Monitoring program by Flanders Environment Agency: shallow groundwater, +/- 180 wells each year





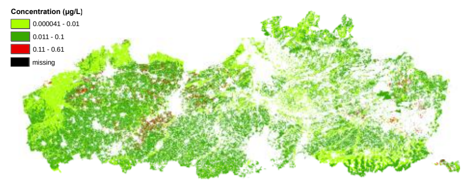
GROUNDWATER VULNERABILITY TOOL

- We developed a tool to calculate groundwater vulnerability maps for PPPs
  - Substance-specific
  - As much as possible process-based (incl. saturated zone)
  - Making optimal use of existing Flemish/Belgian datasets and models
  - At different scales (Flanders and local)

- We consider in this study 'specific vulnerability' taking into account subsoil characteristics and substance characteristics

Tool for vulnerability maps

Flanders-scale



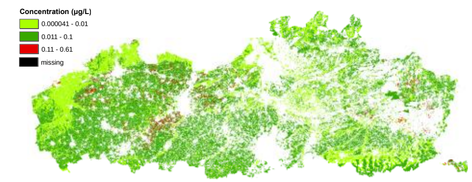
Leaching calculations

+

Indices for saturated zone

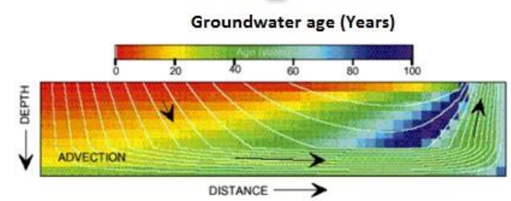
Hybrid method

Local-scale



Leaching calculations

+



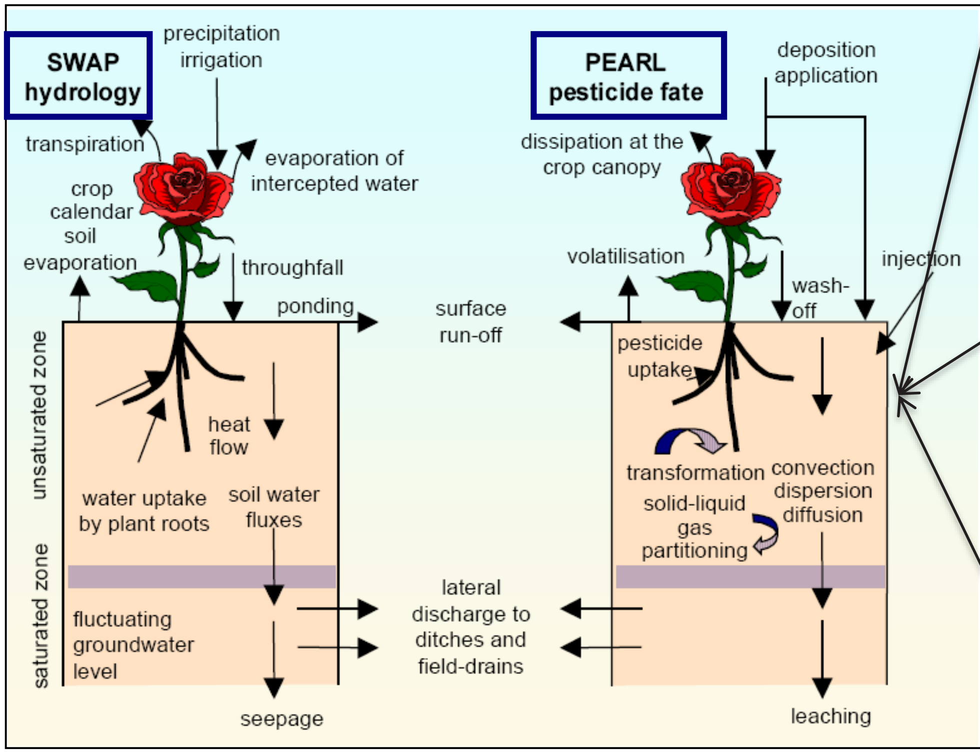
Flowline calculations

Process based method

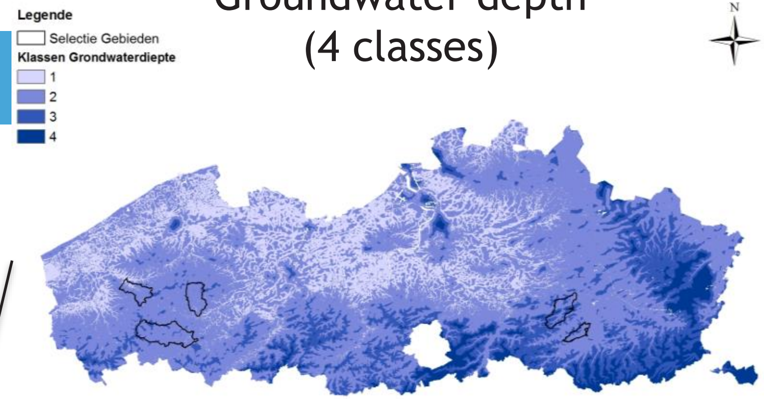
REGIONAL SCALE VULNERABILITY

Leaching to groundwater - GeoPEARL

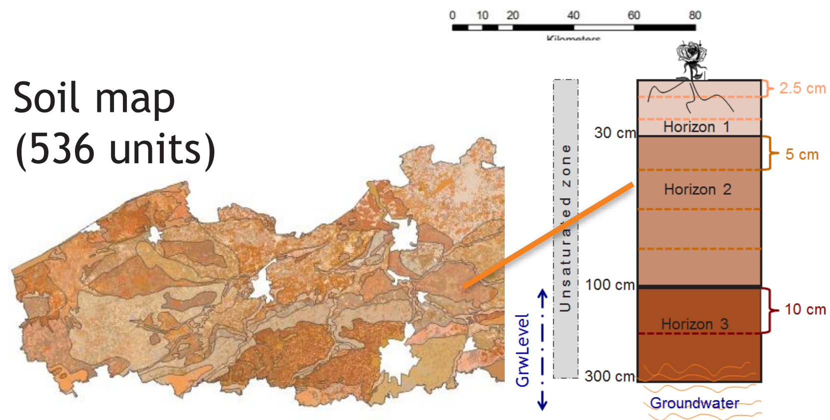
» Hydrological model SWAP
» Pesticide fate model PEARL



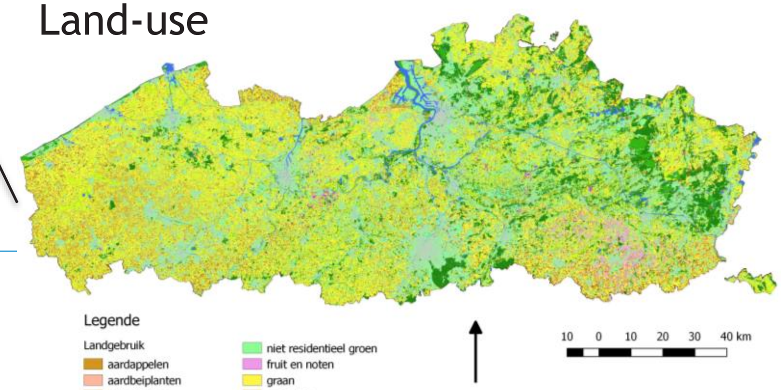
Groundwater depth
(4 classes)



Soil map
(536 units)



Land-use



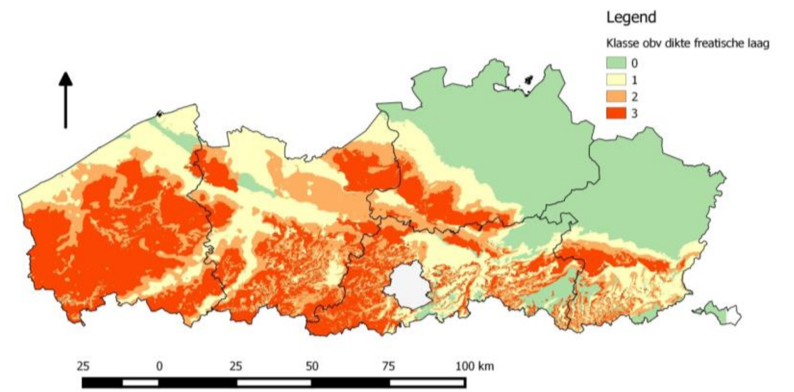
TOOL FOR GROUNDWATER VULNERABILITY – REGIONAL SCALE

Tool will follow a hybrid approach with a combination of process-based calculations for leaching to groundwater and indices for the vulnerability of the saturated zone

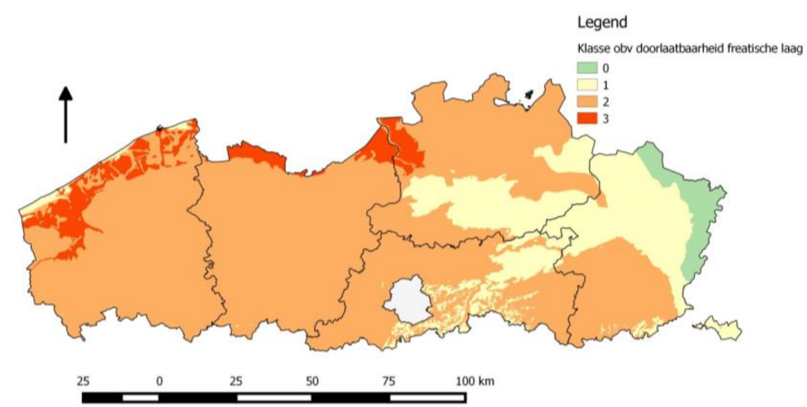
Leaching concentrations

P90-concentrations over 20-yr period

Indices for subsoil vulnerability



Thickness of phreatic layer



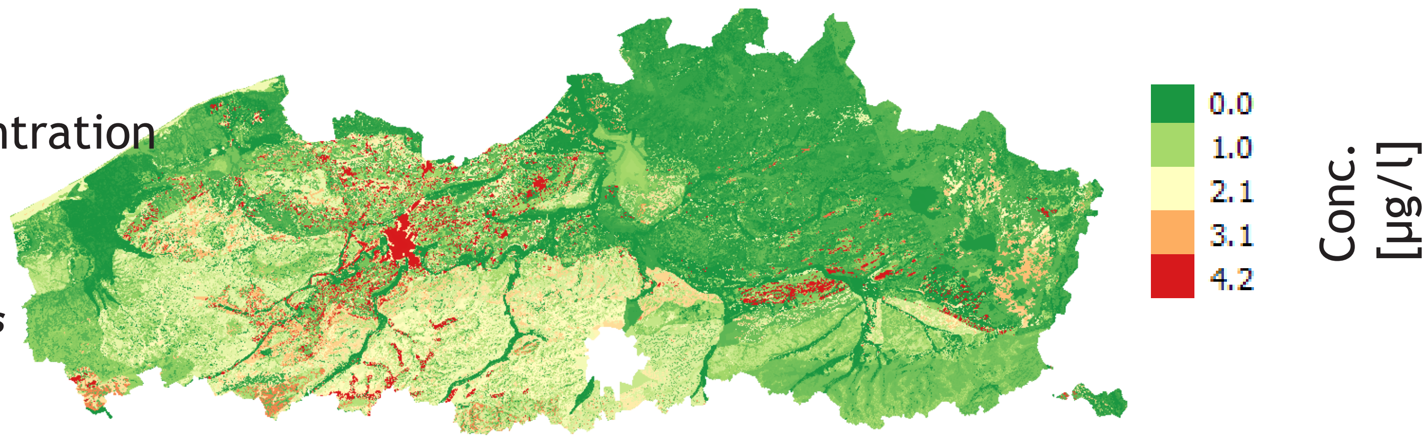
Conductivity of phreatic layer

RESULTS

Flanders-scale

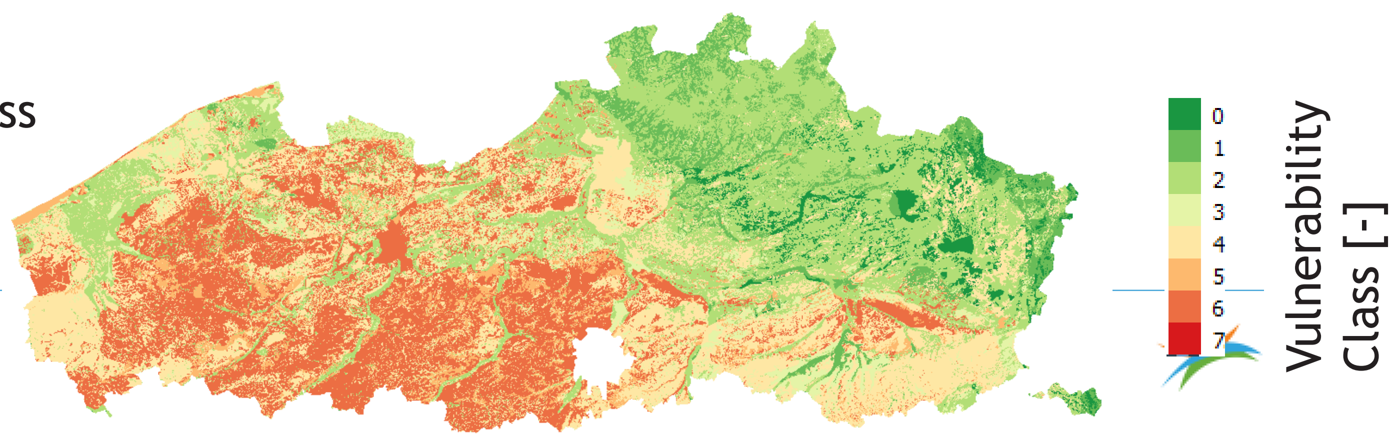
- Example:
  - Vulnerability of phreatic groundwater in Flanders for pesticide x
  - Settings: properties of pesticide x (molmas, Koc, DT50,..) and typical application dose and time, applied on entire Flanders as if maize

P90
Leaching concentration



Classified
Combined with indices saturated zone

groundwater-
vulnerability class



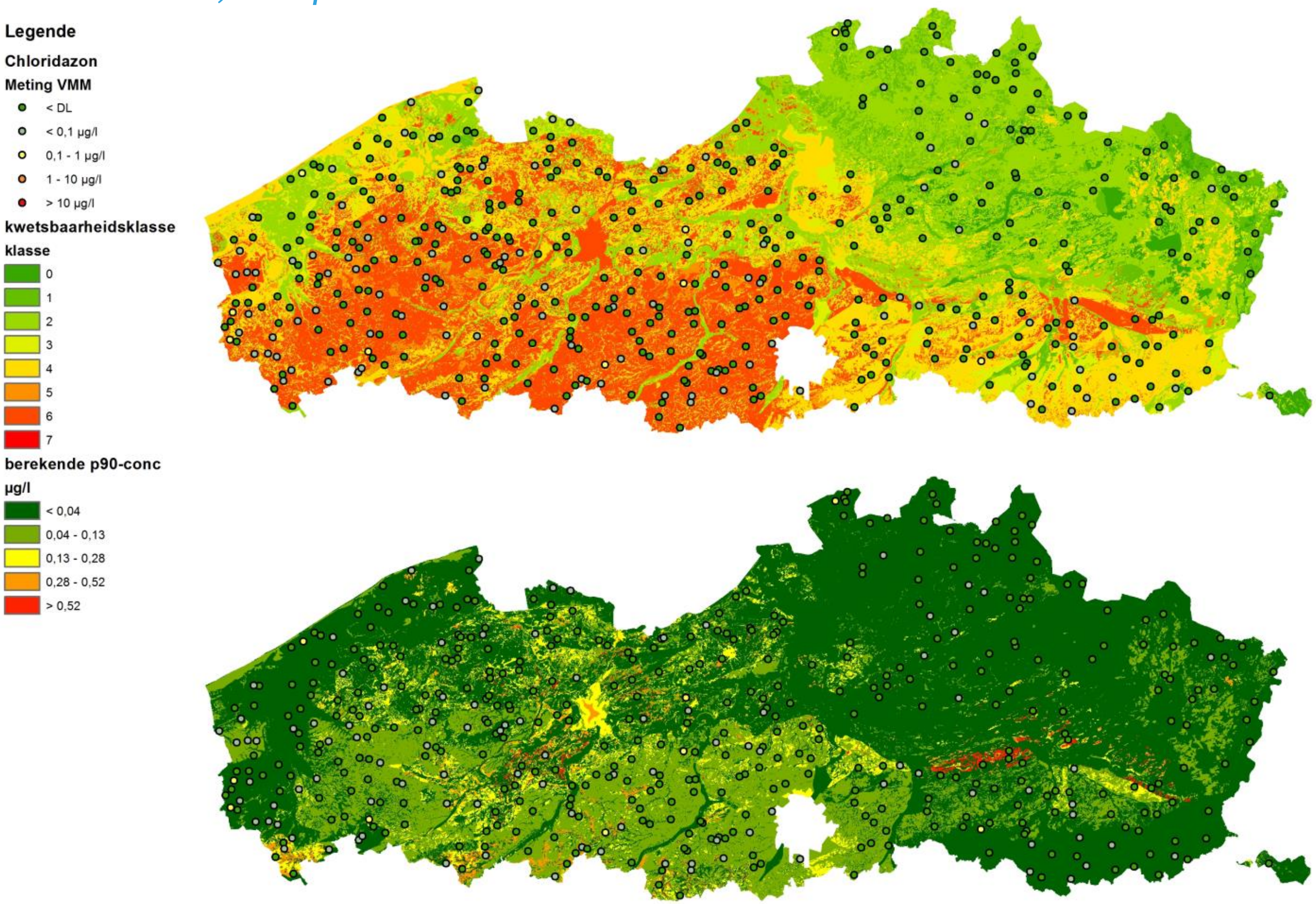
CONFRONTATION WITH MONITORING DATA

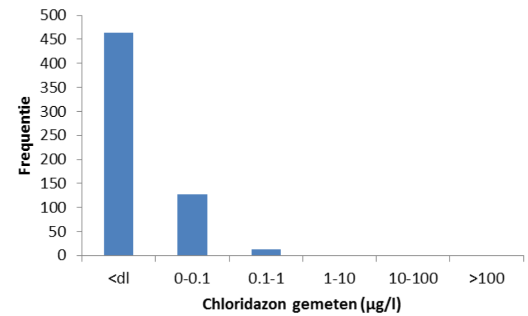
- Semi-quantitative approach comparing the spatial distribution of vulnerable and less vulnerable zones with spatial distribution of findings (measurement above LOQ) of pesticides

- VMM monitoring data:
  - period 2006 to 2014
  - 698 filters; 8000 samples; 56 pesticiden
  - in 16% of the measurements one or more pesticides detected

CHLORIDAZON

Mobile, non-persistent

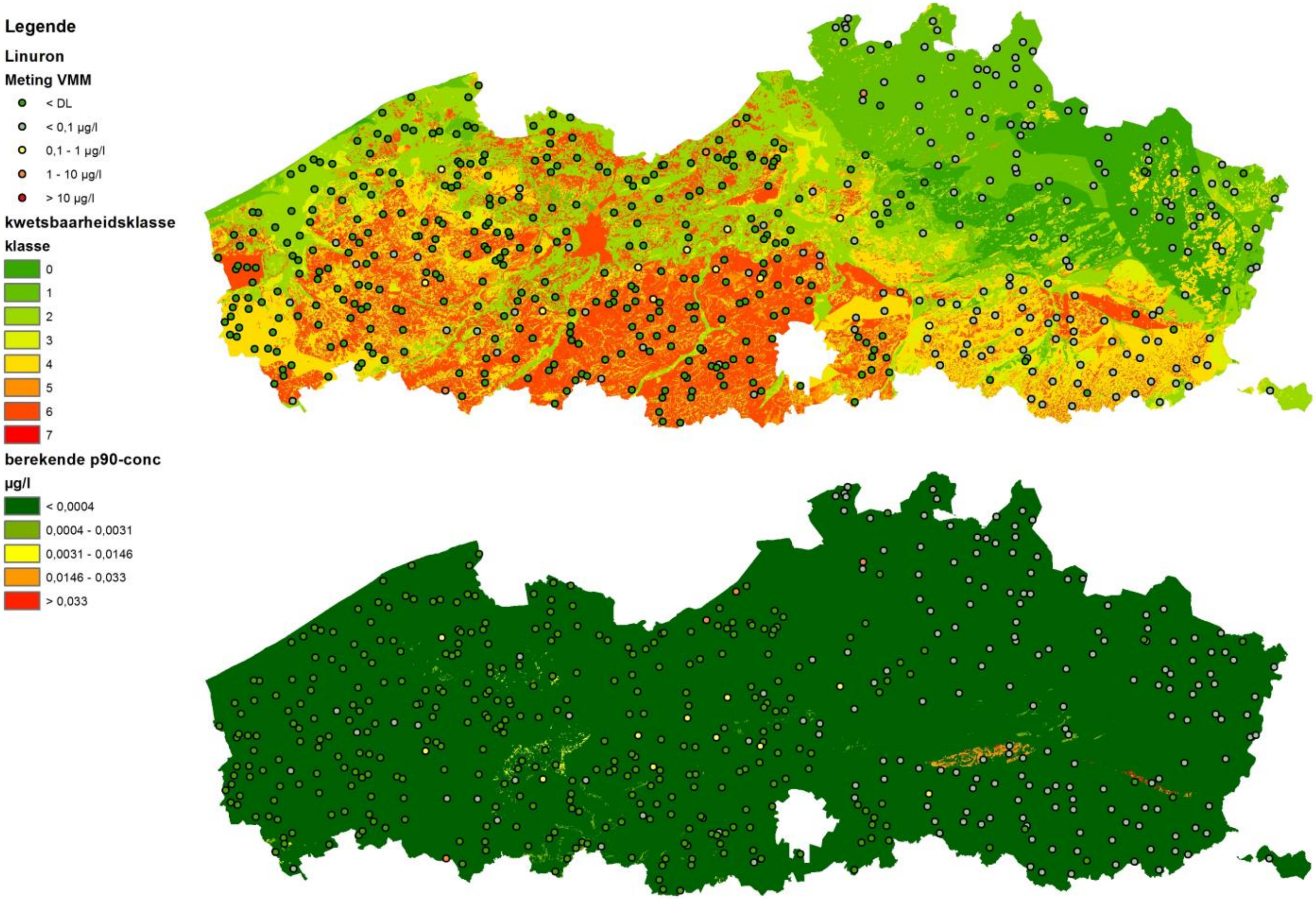


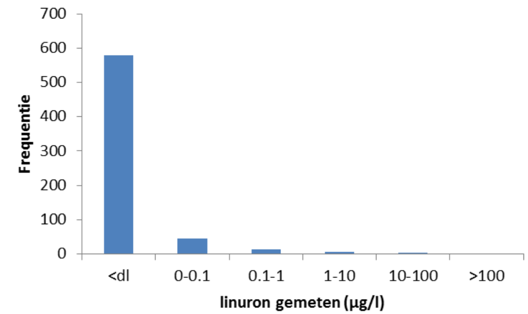


vito

LINURON

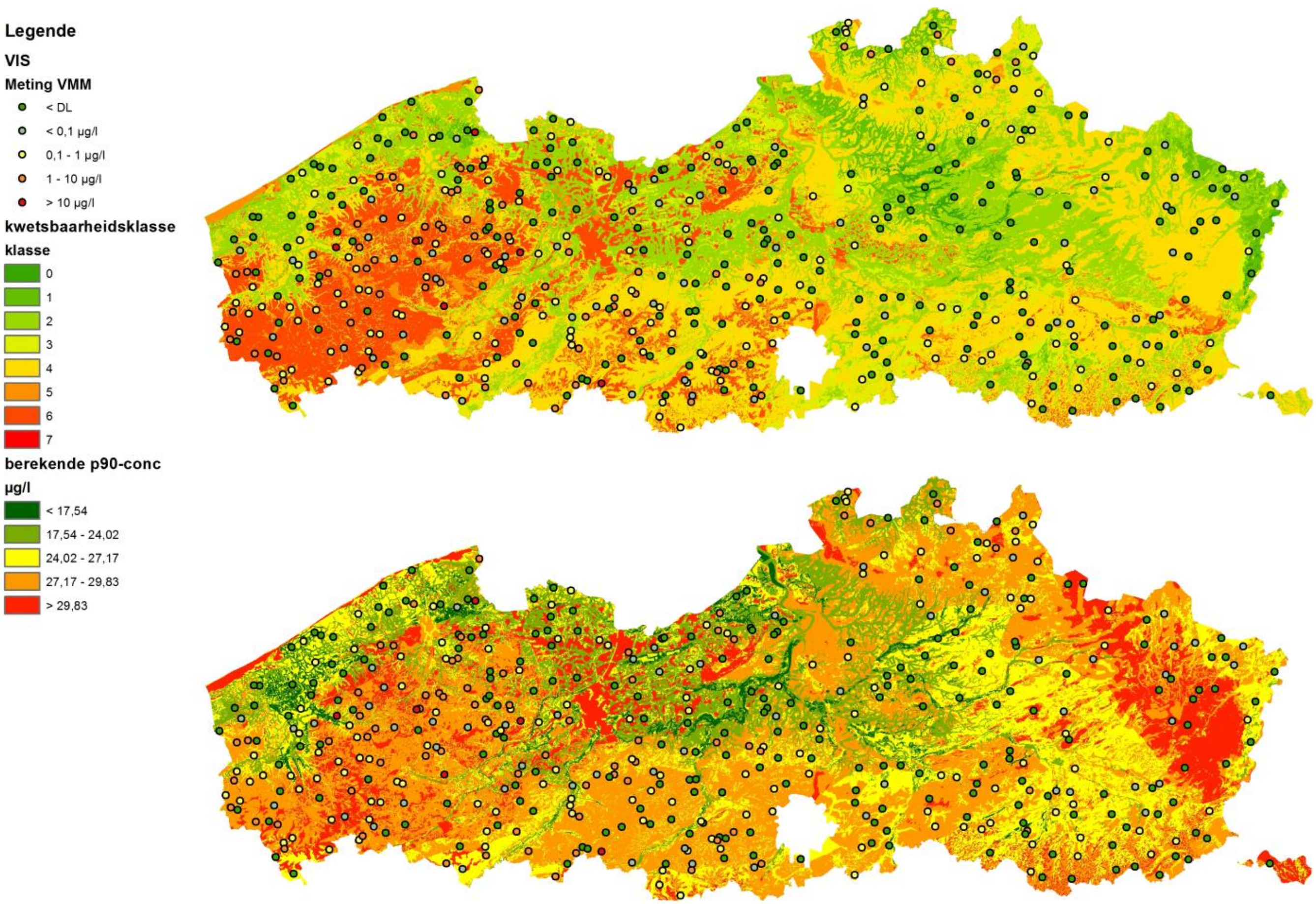
Not mobile, non-persistent

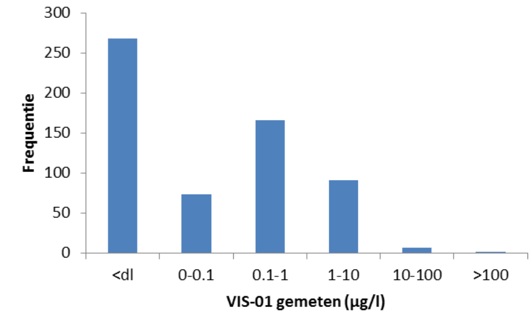


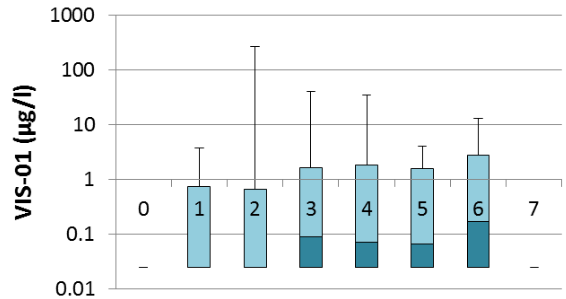


VIS-01 (METABOLITE OF CHLORTHALONIL)

Mobile, persistent







LOCAL SCALE: EXPLANATION OF FINDINGS

- Three selected wells with exceedances or elevated concentrations over a longer period of time; focus on maize herbicides

- Analysis of findings based on:
  - Monitoring data
    - Measured concentrations
    - Setting in the landscape, groundwater levels
  - Delineation of infiltration area of wells
    - Analysis of land-use
    - Farmer survey for actual use and agricultural practices

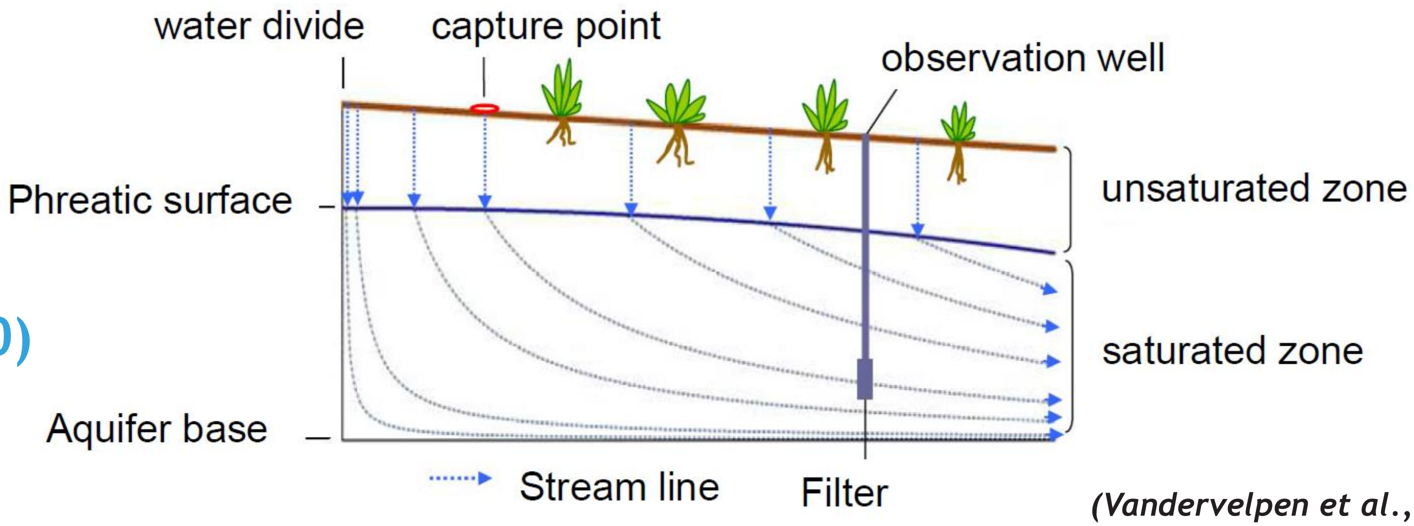
DELINEATION OF INTAKE AREA

Based on:

1. Groundwater flow direction
2. Length capture zone calculated based on
   - » Filter depth
   - » Thickness phreatic layer
   - » Distance to water divide

GAMACTT (v1.0)

Böhlke et al., 2014

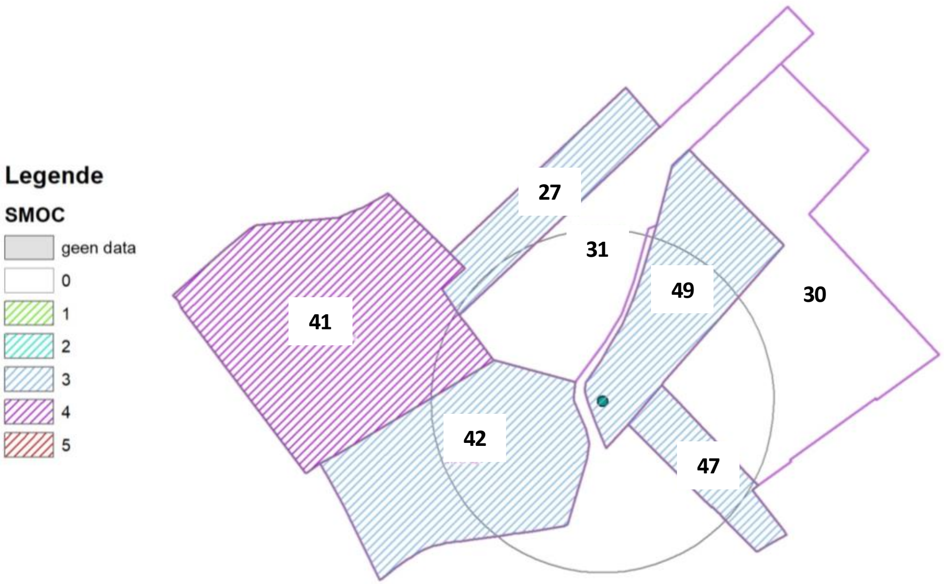


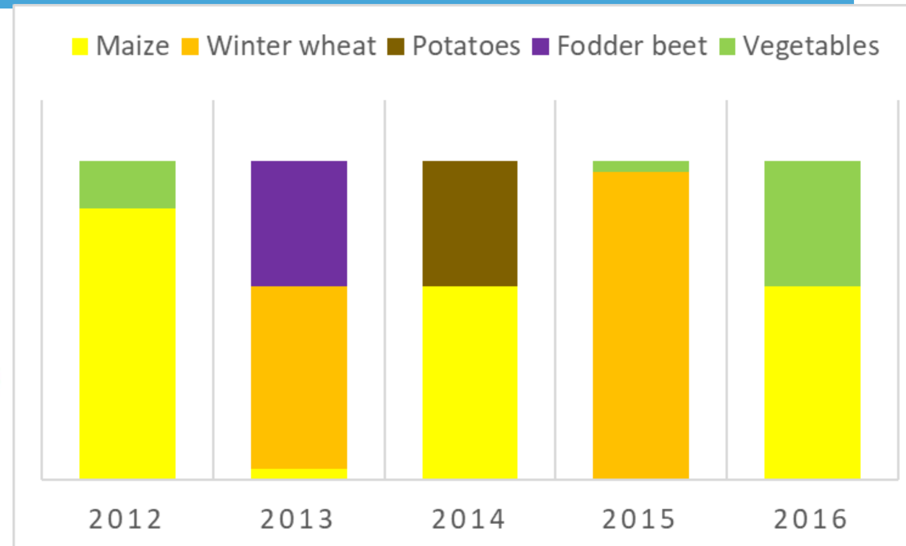
(Vandervelpen et al., 2011)

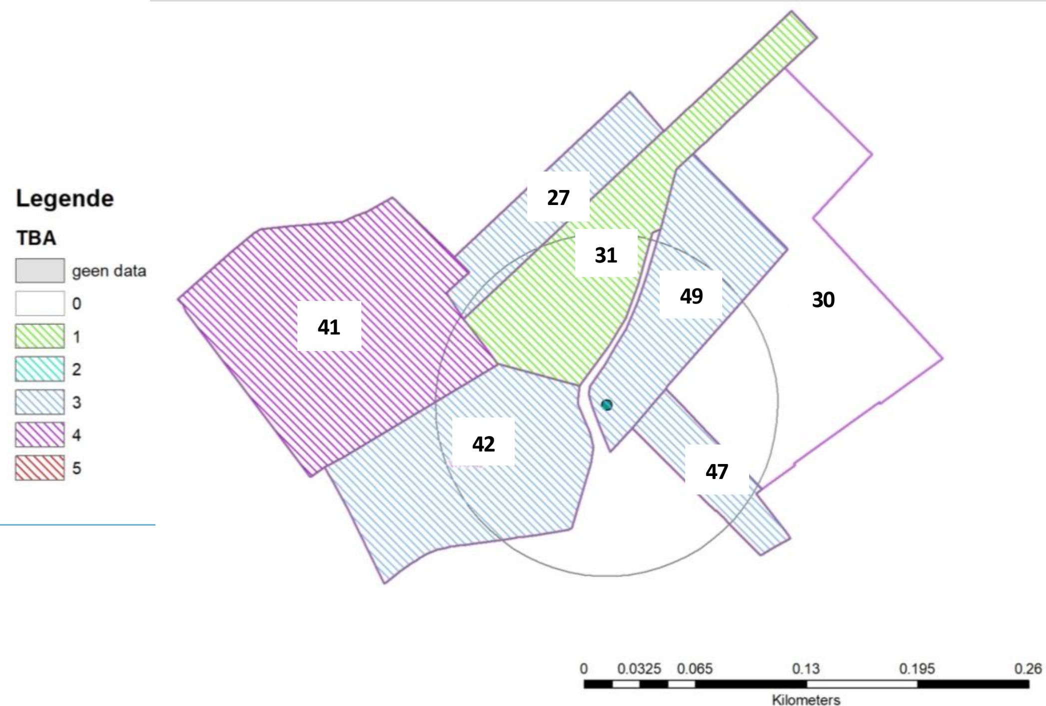
WELL NUMBER 1 - LEEST

- Frequent exceedances for S-metolachlor and terbuthylazine of the 0.1 µg/l threshold over the last 10 years
- Shallow groundwater (1.3 mbgl on average)
- Flat topography: small intake area (radius<100 m) and inconclusive information on groundwater flow direction

WELL NUMBER 1: ANALYSIS OF USE







WELL NUMBER 1: VULNERABILITY

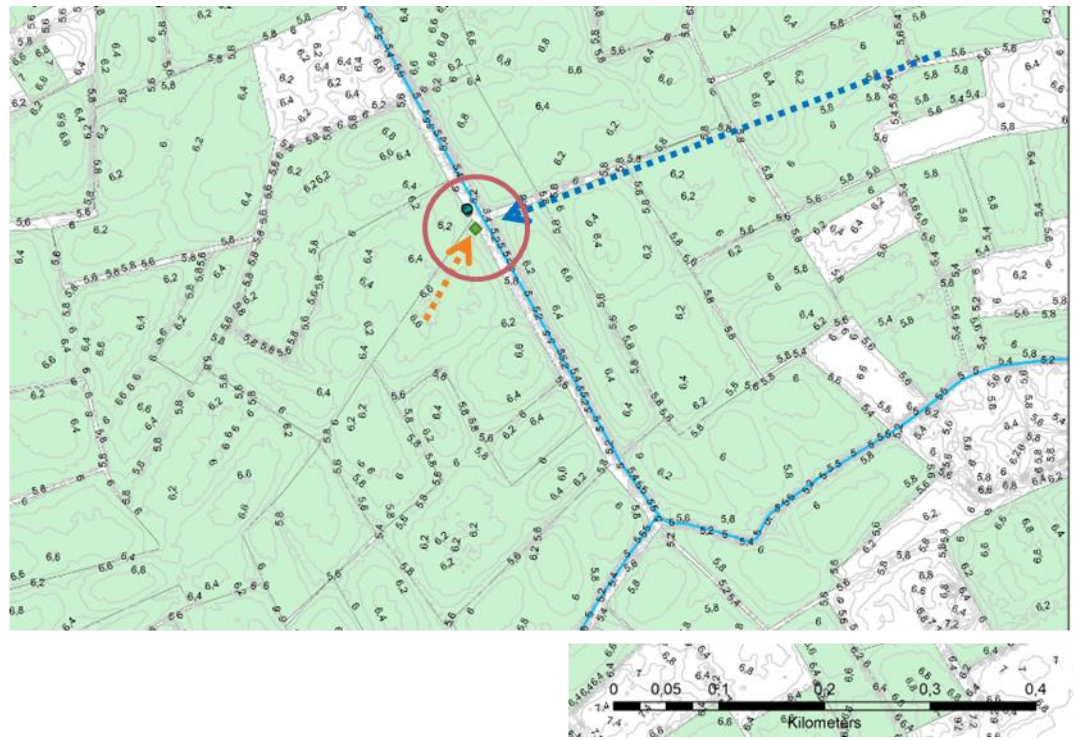
- Site vulnerability for SMOC and TBA is low (class 1)
- realistic worst-case scenario considering yearly application of the substance
- local settings of soil and climate are unlikely to explain the measured concentrations
- substances reach the well through a fast route such as drainage systems

WELL NUMBER 2 - WAASMUNSTER

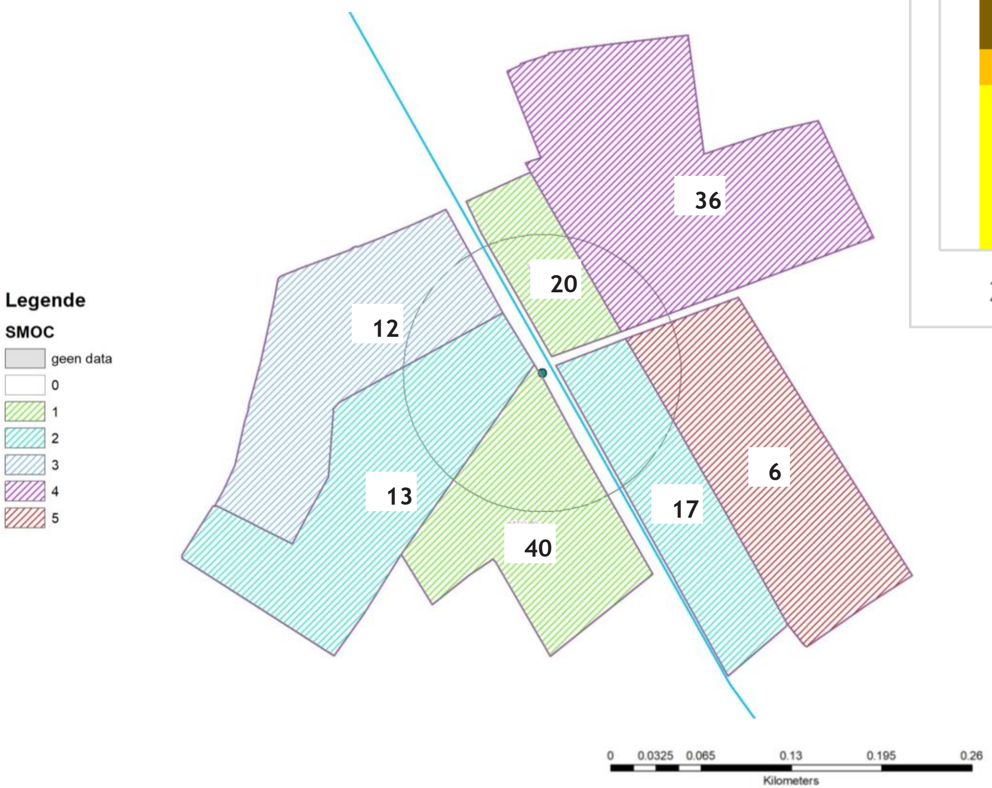
» Elevated concentrations for S-metolachlor-ESA; exceedances for bentazon in period 2007-2009

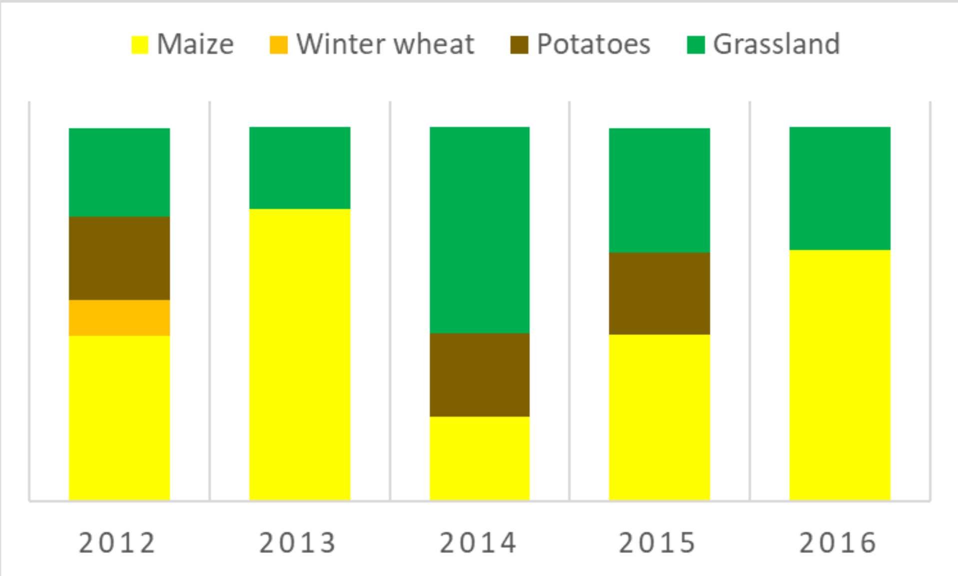
» Shallow groundwater (0.84 mbgl on average)

» Flat topography: small intake area (radius<100 m) and inconclusive information on groundwater flow direction



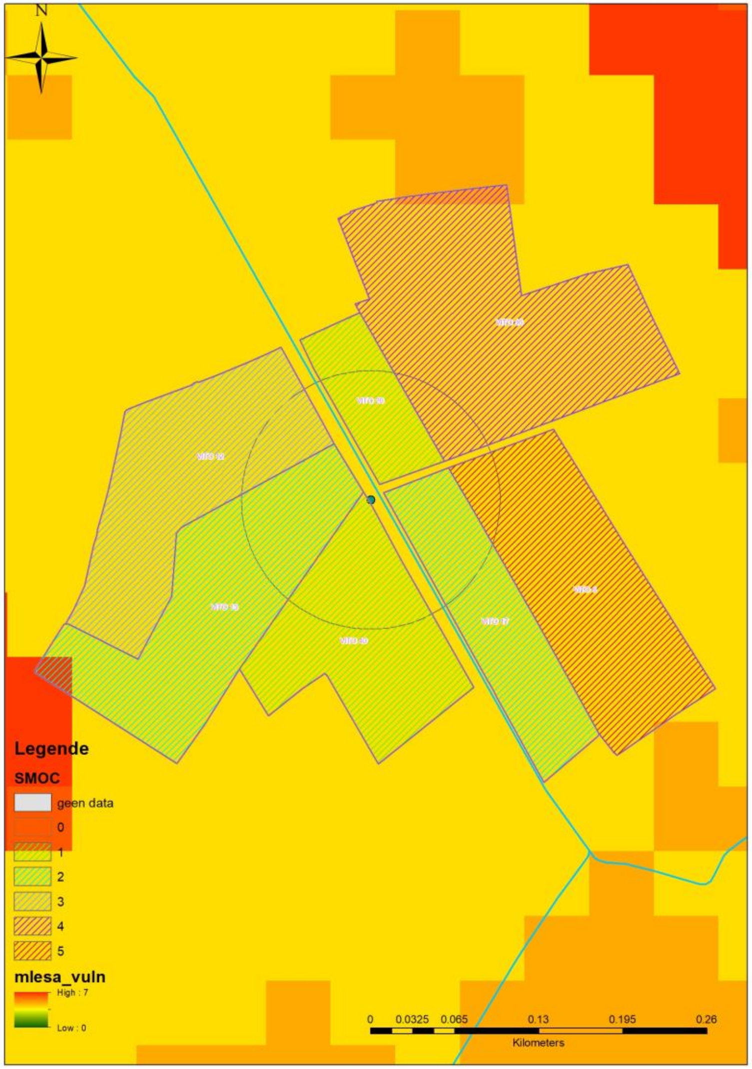
WELL NUMBER 2: ANALYSIS OF USE





WELL NUMBER 2: VULNERABILITY

- Calculated site vulnerability for SMOC is class 4
- Site vulnerable for leaching because of the sandy soil and high groundwater table
- leaching through soil can be considered at least partly responsible for the high concentrations found (supported by the exceedances found in the past for bentazone)
- no direct indication of anomalies related to the use of SMOC (one incident reported of cleaning of a sprayer in the river)

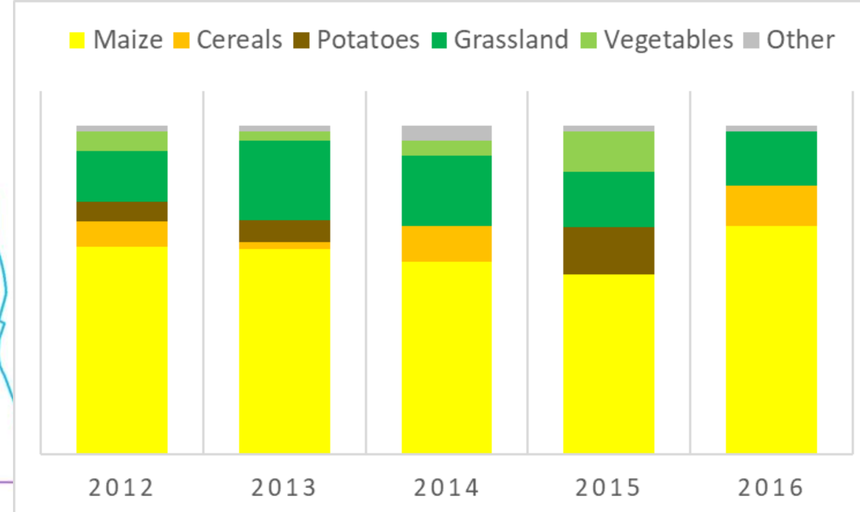


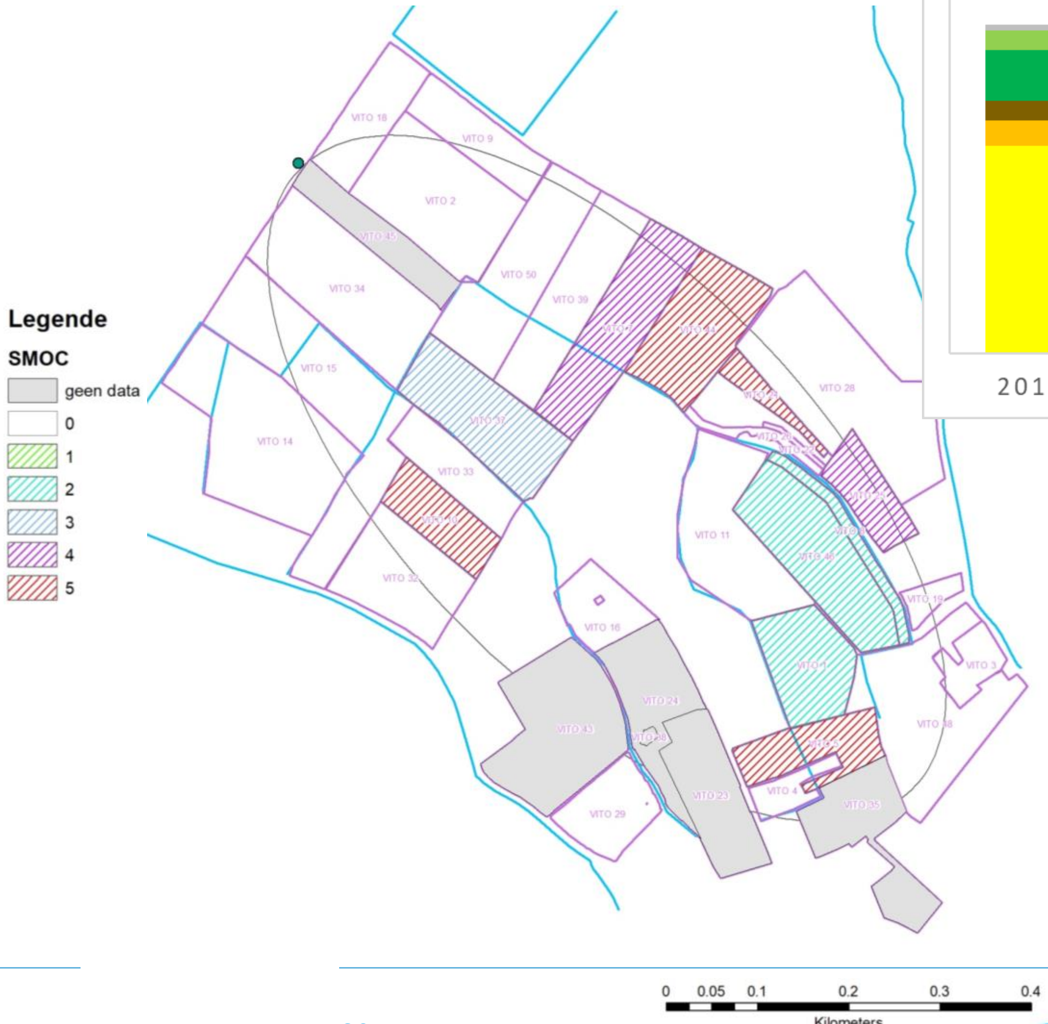
vito

WELL NUMBER 3 - KRUISHOUTEM

- Elevated concentrations for S-metolachlor-ESA; exceedances for bentazon in period 2006 to now
- Shallow groundwater (1.1 mbgl on average)
- Distinct topography: large intake area (length~1 km) and groundwater flow downhill

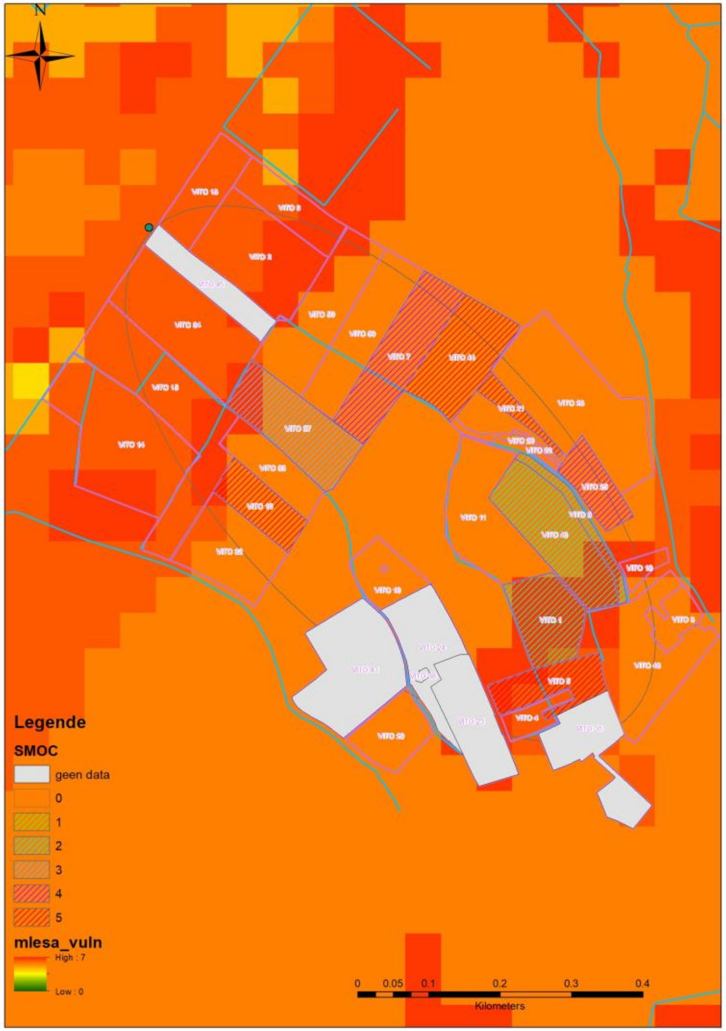
WELL NUMBER 3: ANALYSIS OF USE





WELL NUMBER 3: VULNERABILITY

- Delineated intake area much larger comprising 36 fields
- Calculated site vulnerability for SMOC is class 6
- Site vulnerable for leaching because of the sandy soil and the shallow groundwater table
- leaching through soil can explain at least partly the exceedances (supported by exceedances found for bentazone) and given the large intake area for the well this can persist for a long period of time
- no indication good agricultural practices are not observed; not all farmers could be reached



CONCLUSIONS

Can vulnerability maps explain pesticide findings in groundwater?

- Groundwater vulnerability maps are useful to screen out wells with potential elevated concentrations and to design monitoring

- To accurately assess the situation around a particular well, local factors (intake area, land-use, use) need to be taken into account

vito

Thank you