HIGHER-TIER APPROACHES TO GROUNDWATER MONITORING

Andy Newcombe and Joseph White (Arcadis)

INTRODUCTION

Currently, there is no formal European guidance for the design of groundwater monitoring studies. The number of groundwater monitoring studies being conducted by industry is increasing and there is a growing emphasis on cost-effective approaches to the identification of suitable monitoring locations and the conduct of fit-for-purpose studies.

This poster will highlight the concept of leaching vulnerability and approaches to refining the identification of candidate groundwater monitoring sites. An overview of different groundwater monitoring study designs and their purpose will also be presented.

LEACHING VULNERABILITY

Leaching vulnerability is defined as the potential for leaching of analytes-of-interest from overlying soil. Leaching vulnerability includes two factors:

- Intrinsic site vulnerability
- External factors

Both factors combined contribute to the vulnerability of a monitoring site.

Intrinsic Vulnerability	External Factors
Climatic Conditions	Application Type, Rate, and Frequency
Soil Properties (e.g. texture, organic matter, permeability)	Cropping factors
Hydrogeology e.g. (groundwater depth, recharge rate, low permeable subsoil layers)	Chemical properties

REFINING MONITORING SITE IDENTIFICATION

The identification of candidate groundwater monitoring sites can be refined through the utilization of Geographic Information System (GIS) and modeling tools to create leaching vulnerability maps.

Maps can display the spatial distribution of leaching vulnerability for focused areas of interest (e.g., 1 km^2, 10 km^2, or county scales).

Increasing Complexity

There are three main GIS based approaches to estimating leaching vulnerability.

Index-based approaches

- Overlay of environmental indicators for leaching risk
- Example described in FOCUS groundwater to derive use-specific realistic worst-case leaching scenarios

Meta-modelling

- Simplified leaching model (e.g., MetaPEARL)

Spatially distributed modelling

- Delineation of multiple scenarios by spatial overlay of geo-referenced crop, weather, and soil data

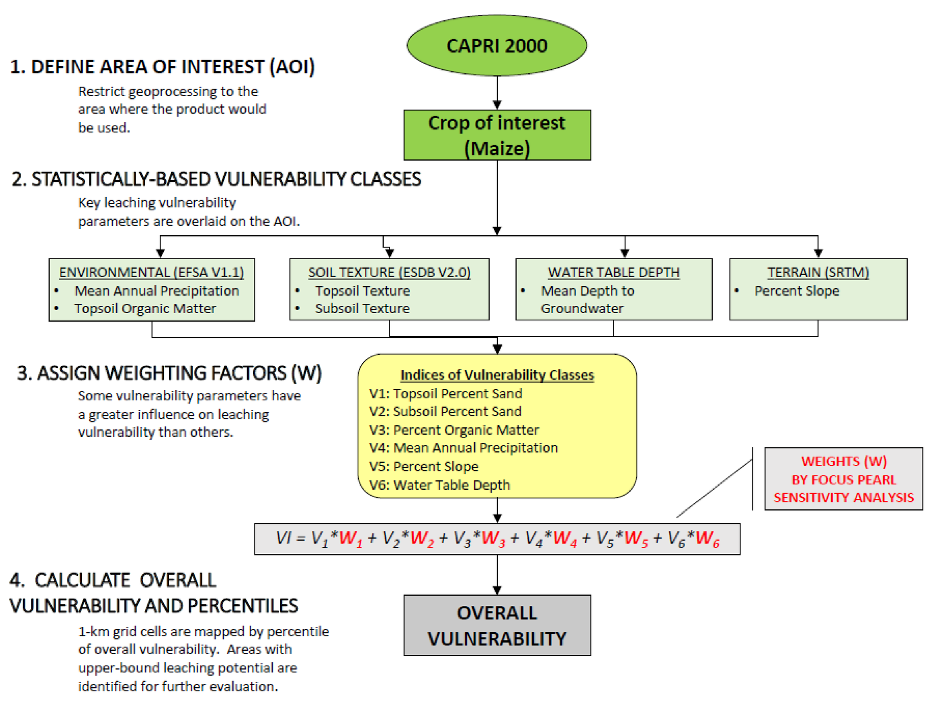
CASE STUDY

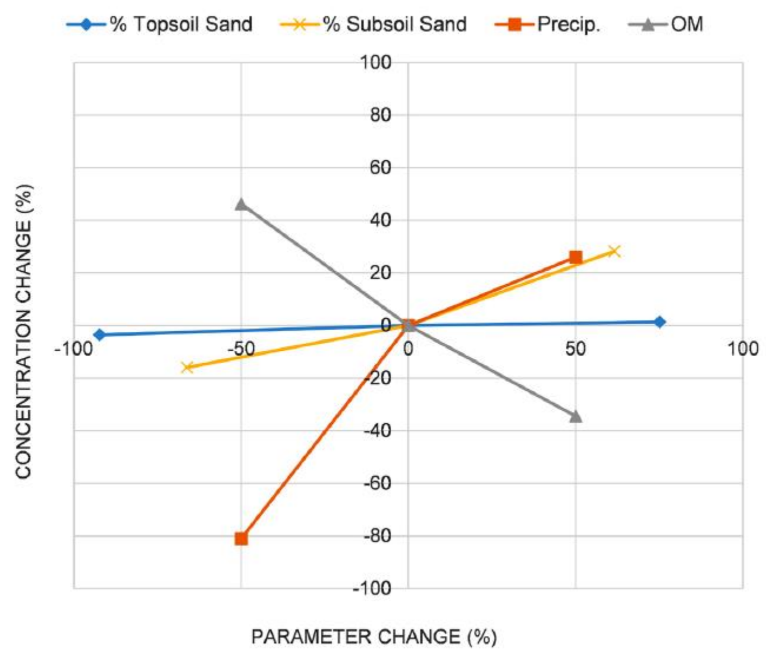
A FOCUS-type approach was used to derive crop specific leaching scenarios and for refining site identification efforts and characterizing leaching potential.

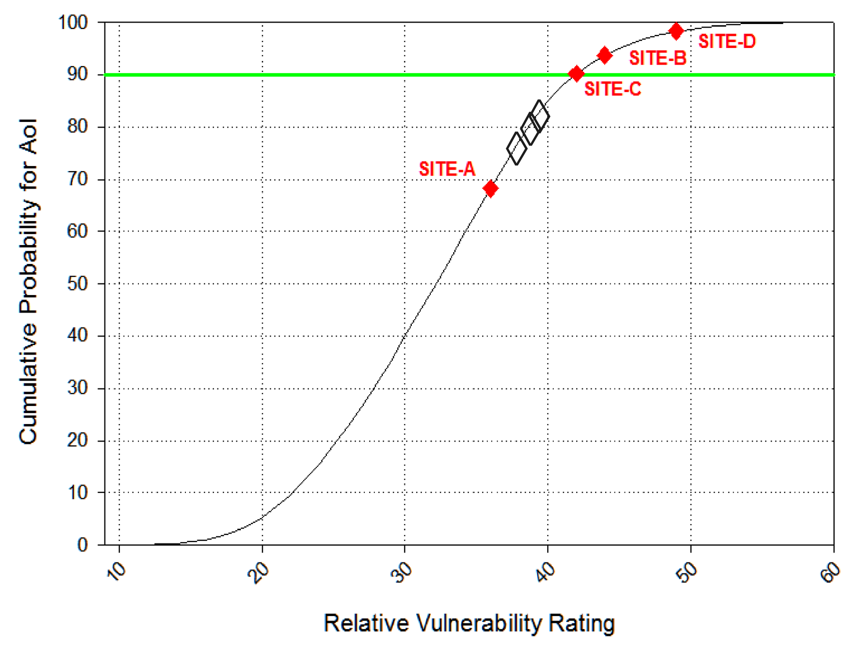
Soil pH was used to target candidate sites on alkaline soils due to pH-dependence of leaching risk.

Parameters were evaluated for pronounced sensitivity in leaching calculations using FOCUS PEARL.

Modeling was conducted to inform the assignment of weighting factors.







Organic matter and precipitation were determined as the most influential leaching parameters.

Candidate monitoring sites were identified within the upper bound leaching potential (70th to 97th percentiles).

Data indicate upper bound leaching potential would be adequately characterized by these monitoring sites.

GROUNDWATER MONITORING STUDY DESIGNS

Groundwater monitoring studies are designed to determine the potential for an analyte(s) to move to groundwater and to quantify residues in groundwater. Studies can be classified into two categories:

Prospective Monitoring

Prospective studies typically involve the application of the test substance and then conducting groundwater monitoring thereafter. Examples include:

- Field Leaching (FOCUS Tier 3)
- Prospective Groundwater Monitoring

Groundwater monitoring wells are typically located within or immediately adjacent to the treated field and these studies often include the application of a conservative tracer and soil sample collection.

Advantages	Disadvantages
Can assess leaching potential of experimental compounds	Significant site identification/characterization costs
Test site soil and groundwater characteristics well defined	Limited understanding of environmental behaviour of products as study performed at small number of sites
Monitoring well placement simplified due to clear understanding of source area	Study duration can be lengthy to meet study termination criteria
Agronomic and irrigation inputs typically closely managed	
Clear regulatory guidance available for studies conducted in North America	
Criteria established for study termination (North America)	

Retrospective Monitoring

Retrospective studies involve the collection of groundwater samples following a number of historical, often commercial product applications to one or multiple fields. These studies typically include multiple monitoring sites to allow for spatial variability to be assessed.

Advantages	Disadvantages
Existing monitoring wells can be used if well integrity and connectivity to treated area can be confirmed	Cannot assess leaching potential of experimental/development compounds
Multiple monitoring sites can be included in a study design allowing for different areas of product use and leaching vulnerability to be evaluated	Soil and groundwater characteristics of treated fields or catchment area typically not well defined
Reduced study conduct costs	Demonstration of connectivity to treated fields or catchment can be challenging
Study duration is typically shorter than prospective studies	Reduced control of agronomic activities due to involvement of commercial farmers
Studies are typically conducted under conventional use patterns and represent "real world" agronomic conditions	

CONCLUSIONS

- Approaches are available to refine the identification of candidate groundwater monitoring sites and to place monitoring locations into a leaching vulnerability context.
- Study designs are becoming more sophisticated in an attempt to ensure studies are acceptable and considered fit for purpose.
- Study designs can be implemented to meet specific objectives.

andy.newcombe@arcadis.com