Groundwater representative scenarios definition at regional/national scale

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Background

- In pesticide registration process, predicted environmental concentration (PEC) in groundwater should be <0.1 µg/l.

- FOCUS GW group has selected models and created "realistic worst case" scenarios to estimate PEC in 1-m depth. None of the 9 FOCUS GW scenarios exists anywhere.

- Refined scenarios could be used in higher tier simulations.

- Refined scenarios can be created at National and Regional level.

- The talk will illustrate the Regional Level:
  - Soil data available for Italy are at "administrative" regional scale and it is impossible to merge them.
  - Italian and European soil maps 1:250000 are not still ready.
Overview

- The case of Lombardia Region will be shown
- 5 crops: corn, soybean, sugar beet, barley and grape
- Procedure to develop scenario step by step
- Scenarios should be representative and differ from each other
- Scenarios obtained were compared with FOCUS GW scenarios
Introducción

WEATHER

SOIL

CROP

has influence on

pesticide use
Material and Methods

The procedure is:

1. Individuation the areas where the crop is cultivated
2. Individuation of the relevant soils of these areas
3. Individuation of the climatic conditions of these areas
4. Overlap of these information to create regional scenarios
5. Modelling
Materials - CROP

- **CORINE LAND COVER (CLC90 - CLC2000)**
  - inventory of European land use
  - Remote sensing based - 250m grid
  - non-irrigated arable land, permanently irrigated land, rice fields, Vineyards, Fruit trees and berry plantations, Olive groves

- 5th Italian agricultural Census & administrative boundaries (source: ISTAT)
  - Statistical database linked to a GIS
  - Single crops areas are reported at municipality scale
  - Data were normalised by agricultural land
Materials - SOIL

- Lombardia 1:50,000 soil map
  - Flat area along the Po valley.
  - is linked with a database containing landscape units and the representative soil profiles
  - 785 different profiles that represent the soils
Materials - CLIMATE

- Climatic Maps
- Weather station dataset
Methods (I)

- CENSUS Analysis
  - Municipalities with maize/arable land ratio > 20% were selected
  - 5 years rotation (Maize, Wheat, Alfa Alfa, Alfa Alfa, Alfa Alfa)
  - Maize can be replaced by sugar beet, soybean, tomato, onion
Methods (II)

- CENSUS + CORINE LAND COVER

Arable lands where maize is a least in a 5 years rotation
Methods (III)

- Soil that intersect crop area were selected for clustering

- Vines and olive trees can be analysed using only CORINE

Vineyards of Lombardy (CLC2000)
Clustering (I)

- Cluster analysis using SAS-System was used to find groups of similar soils.
- Cluster is a group of objects with similar characteristics
- Characteristics (variables) depend on the aim of the research
Clustering (II)

- The SAS-CLUSTER procedure finds hierarchical clusters of the observations in a SAS data set and computes Euclidean distances.

- In the present study clustering was done using average method that requests the average linkage (Sokal *et al.*, 1958) where the distance between two clusters is the average distance between pairs of observations, one in each cluster.

- All the SAS CLUSTER methods are based on the usual agglomerative hierarchical clustering procedure. Each observation begins in a cluster by itself. The two closest clusters are merged to form a new cluster that replaces the two old clusters.
The clustering variables

• 38 variables were used:
  - \( \frac{2}{3} \) of variables: soil properties affecting sorption and degradation
  - \( \frac{1}{3} \) of variables: soil properties affecting hydrology

• Soil horizons were taken in account
  - 12 variables for OC%
    • depths: 0-5cm, 5-10cm, 10-20cm, 20-30cm, …, 70-80cm, 80-100cm, 100-120cm, 120-200cm
  - 6 variables for clay, pH, available water content, permeability class
    • depths: 0-10 cm, 10-30 cm, 30-50 cm, 50-70 cm, 70-100 cm, 100-200 cm
  - single variables for soil drainage group and for groundwater depth
The selected clusters

- Cluster were selected to reach the 2/3 of selected crop and soil area
- Clusters with area <5% of the total area were excluded (only representative selected)
- Within a cluster the soil properties used coming from the soil profile with highest area (dominant)

  (e.g. the cluster median values of soil properties should be another choice. However, the idea was to get real scenarios and not hypothetical average.)
Distance between clusters set to 0.12 due to expert judgement

Sugar beet clusters, the most common soils identified by letters (A-I)
Example of sugar beet clusters (the 3 with highest area)

the most common soils are identified by letters (A-I)
Results - The Climate

- Regional Meteo Survey identified 15 Climatic areals
- The nearest stations to the soil was selected
Results - The scenarios

- **CORN scenarios**: 7 soils + 5 climates → 8 combinations
  - BTU1
  - CBR1
  - LEO1
  - CPV1
  - CAG1
  - LOD1
  - BEL1

- **SOY BEAN scenarios**: 7 soils + 3 climates → 7 combinations

- **SUGAR BEET (and BARLEY)**: 9 soils + 3 climates → 9 combinations

- **GRAPES**: 5 soils + 3 climates → 5 combinations
• FOCUSPELMO version 3.3.2.

• The climate data were available for 12-13 years depending on the station.

• The missing soil parameters were obtained using pedotransfer

• The Crop parameters were from FOCUS Piacenza scenario.

• An hypothetical pesticide (FOCUS-DUMMY-A) was applied 1 kg/ha a day after the emergence every year. (Koc= 103 mL/g, DT50= 60d)

• The outputs were taken from simulation years 7-26 as the pesticide registration procedure requires.

• Results were compared with FOCUS GW Scenarios
Results – Simulations (I)

- a) maize
- b) soybean
- c) sugar beet
- d) vine

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**Legend:**
- Red bars: mean concentration
- Blue bars: water flow
- Orange bars: 80th percentile

## Results Simulations (II)

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<tr>
<th>Scenario</th>
<th>area (ha)</th>
<th>%</th>
<th>n. of soils</th>
<th>Soil</th>
<th>Climate</th>
<th>pesticide g/ha</th>
<th>water l/m²</th>
<th>Concentration µg/l</th>
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Conclusions (I)

• This study demonstrated a possible way to create regional scenarios with a procedure repeatable and transparent. The selected scenarios developed are representative of the regional agriculture and also they include soils that are both vulnerable and protective to pesticides.

• The step by step procedure reduced progressively the soil surface employed in the analysis, obtaining as final result a small number of soil (5 to 9) that represents more than 66% of the surface of each crop.

• The annual average leaching of each crop from FOCUS scenario was higher than representative ones. In particular the mean values from FOCUS scenarios simulated for each crop are always higher than the regional representative scenarios. Therefore FOCUS scenarios represent really the worst cases according FOCUS aim and are suitable for a first evaluation of pesticides.
Conclusions (II)

• The Piacenza FOCUS is always the most vulnerable scenario as showed by APECOP project.

• For that reason it is necessary to develop a further tier to evaluate in depth the behaviour of pesticide using representative scenarios. (Refinement)

• Since inside each scenario groups there is an high variability, the need to use a set of scenarios is essential to establish the unacceptable risk of the compounds to people or to the environment.

• Further studies should optimise the clustering variable set.
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