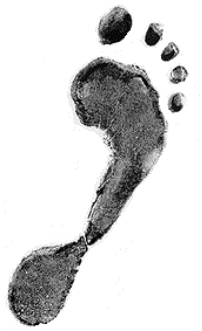
What are the Key Climatic Factors Determining Pesticide Loss in Drainflow and Leaching?



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Objectives

> **Goal**: develop realistic climatic zones for pesticide risk assessments in Europe

> Identify key climatic factors influencing pesticides loss from among

- Application season (spring vs. autumn)
- Rainfall volumes and timing
- Temperature
- Clay content

Approach

> Variables
- Leaching (720 runs), drainage (900 runs)
- Application season (spring vs. fall) and date
- 9 soil types
- 3 pesticides
- 6 synthetic climate series

> Generate 1,620 MACRO runs to compute total pesticide loss for each of 54 season-soil-pesticide scenarios

☞One application date in one climate series was excluded because of significant rainfall

The usual approach

> The definition of climatic scenarios for pesticide fate and modelling typically is based on average temperature and average annual rainfall…

> …but are these the most important variables regulating pesticide loss?

Fig 1: Suggested Climatic Zone Map of Europe

FOCUS, 1995

TABLE 2.: Definition of the climatic scenarios

Scenario number	precipitation excess class (mm yearly)	temperature class (°C annual average)
1	<400	0-5
2	>400	0-5
3	<400	5-10
4	>400	5-10
5	<400	10-15
6	>400	10-15
7	<400	15-20
8	>400	15-20

FOCUS, 1997

Characterization of climatic series

Over 100 variables representing…

- ***Cumulative rain* for indicated time (days) before or after application**

  Rx [x = -91, -61, …, 0, 1, 2, …, 14, 30, 61, …, 365, 729]

- ***Average temperature* over indicated time (days)**

  Tx [x = 0, 1, 2, …, 14, 30, 61, …,365, 729]

- ***"Lag" time in days until single-day rain event (mm) before or after application***

  Ly [y = -30, -20, -10, 10, 30, 40, 50]

- ***Time in days for cumulative rain amount (mm)***

  Cy [y = 2, 5, 10, 20, 50, 100]

- ***Winter rain* amount for indicated months**

  WRA_m_n [m = Sep, Oct, Nov; n = Mar, Apr]

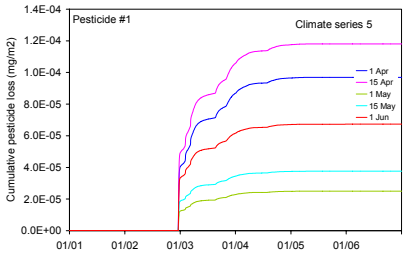
Pesticide Properties

- ***Pesticide 1***
  - Mobile
  - Slightly persistent
- ***Pesticide 1***
  - Moderately mobile
  - Moderately persistent
- ***Pesticide 3***
  - Moderately mobile
  - Very persistent

Soils

- From 9 – 56% clay to represent broad range of soil conditions in Europe

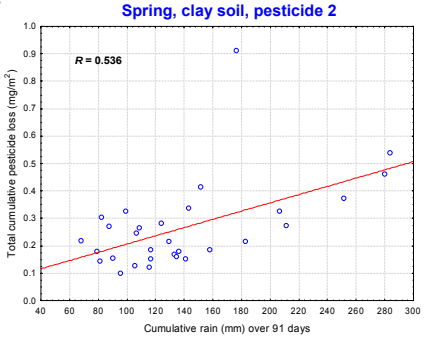
Pearson Correlations – Leaching Examples



← Typical MACRO output

Total cumulative pesticides loss is the dependent variable for correlations analysis.

Spring, clay soil, pesticide 2



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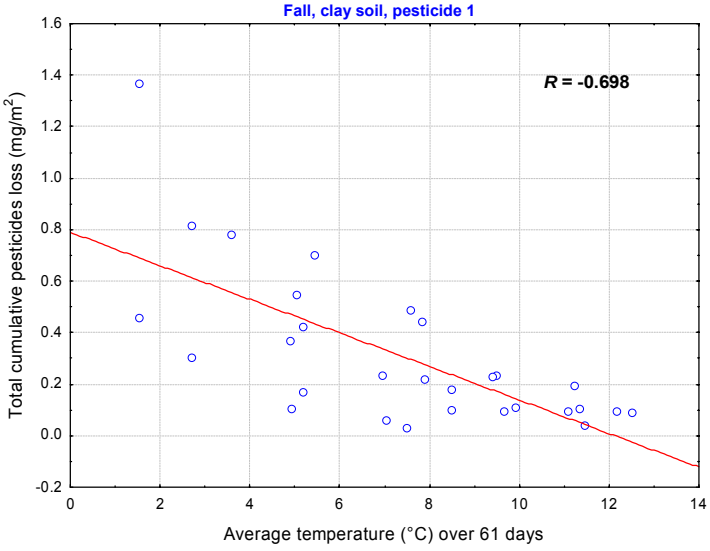
Pearson Correlations – Drainage Example

Fall, clay soil, pesticide 1



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Pearson Correlations – Leaching

Example for a Single Season-Soil-Pesticide Scenario

Ludford soil					
Pesticide 1		**Pesticide 2**		**Pesticide 3**	
L50	***-0.648***	***WRA_nov_apr***	***0.862***	***WRA_oct_apr***	***0.973***
R10	***0.494***	***WRA_nov_mar***	***0.822***	***WRA_nov_apr***	***0.971***
R61	***0.487***	***WRA_oct_apr***	***0.813***	***WRA_sep_apr***	***0.925***
C100	-0.474	***WRA_sep_apr***	***0.789***	***WRA_oct_mar***	***0.918***
R20	0.463	***WRA_oct_mar***	***0.787***	***WRA_nov_mar***	***0.869***

The top 5 correlated variables are shown for each soil-pesticide combination

Aggregated Leaching Results − Pearson Correlations

Summary of all 24 Leaching Scenarios

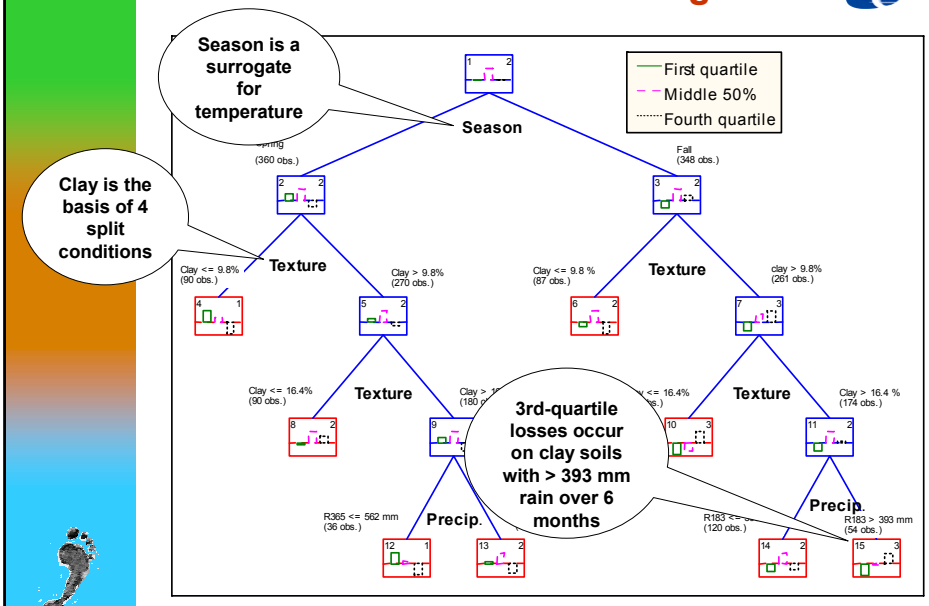
Typical scenario under which the climatic variable Is highly correlated with pesticide loss

Climate variable	Number scenarios influenced	Timescale, months 0 – 3	Timescale, months 3 – 120	Pesticide characteristics	Soil type
Winter rain	**10**	●	●	↑Persistence, ↓Mobility	Structured soils
Long-term rain	**7**		●	↑Persistence, ↓Mobility	Sandy soils
Short-term rain	**4**	●		↑Mobility, ↓ Persistence (spring)	Structured soils
Short-term temp.	**2**	●		↑Mobility, ↓ Persistence (autumn)	Structured soils
Lag time	**1**	●		Various (spring)	Various

Influence

Most of the influential factors are « short-term » (≤3 months), which has implications for the European climatic zonation.

Classification Trees - Leaching



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Results

>Drainage

Pearson results similar to leaching, except

> Winter rain has less influence on pesticides loss

> Short-term rain and temperature (< 60 days) have more influence

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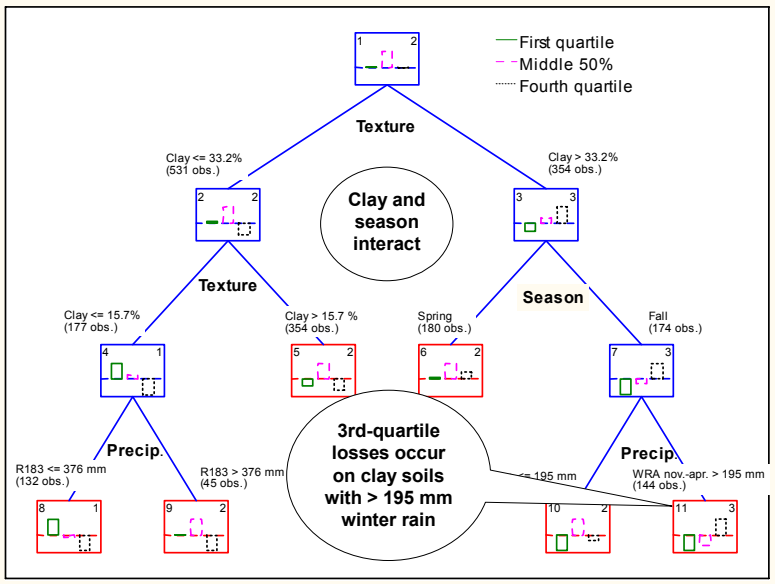
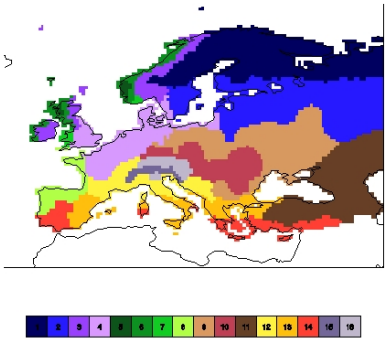
Classification Trees - Drainage



Conclusions, continued

> The factors were subsequently used to derive a climatic classification of Europe.



Blenkinsop et al., *Developing climatic scenarios for pesticide fate modelling in Europe*, in press

Conclusions

- Overall, the timing of rainfall relative to the pesticides application date is important. All of the climate variables were referenced to application date, and many were highly correlated with pesticide loss.
- Clay is a dominant factor affecting pesticide loss in leaching and drainage
  - Decision basis for classification trees
  - Controls correlations with climatic variables
- Strong influence of winter rain for both spring and autumn applications
  - Leaching primarily
  - Less mobile and more pesticides

Conclusions, continued

- More mobile pesticides influenced by short-term rain and temperature
  - Especially on structured soils with high clay content
  - Consistent with a mobile pesticide moving rapidly through macropores in drained soils
- Verification with data from Zaragosa, Spain
  - Verifies short-term rain effect seen at Oxford
  - Temperature effect more widespread at Zaragosa and winter rain less influential.
  - Areas of dissimilarity indicate additional variables needed for subsequent European Union scale analysis (more short term climate variables were added).

Merci pour votre attention!

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