Specific scenarios supporting the registration of plant protection products in Belgium

M. Vanclooster[1], G. Hecquet[1,] , A. Argeles J.D. Pineros[1],
L. Pussemier[2], S. Beernaerts[2], Ph. Debongnie[2], L. Bellefontaine[2], and Q. Mariage[2]

UCL, Department of environmental sciences and land use planning,Unité Génie Rural,
LOUVAIN-LA-NEUVE, Belgium

CERVA, Veterinary and Agrochemical Research
TERVUREN, Belgium

Table of contents

- Introduction
- Data bases supporting the creation of Belgian scenarios
- The pesticide leaching model
- Implementation: the PELEP-DSS
- Some experiences

Introduction

Context of the project

- Directive 91/414/EU: ‘ Uniform principles ’ for registration of crop protection products
  - “...Use validated simulation models for PEC to groundwater, surface water and air…”

Standard scenario: FOCUS groundwater scenarios at EU level

Some remarks, some problems

- Pragmatic approach, based on expert judgement
- Scenario selection based on soil and climate
  - No hydrogeological information was considered
  - No agricultural practice was considered
- Only tier 1 approach

Further scenario development is needed!

- To downscale to the member state level
- To develop coherent methodologies for higher tier assessments

Objective of PELEP project

- To develop country specific scenarios supporting the national authorization process of active substances

- To link these scenarios to an existing pesticide leaching model and implement this in a Decision Support system to assess PEC groundwater for Belgium

Data bases supporting the creation of Belgian scenarios

Design criteria

- Relevant for agricultural use of plant protection products in Belgium
  - ☞ Based on the agricultural area map
- Consider the variability in time of the leaching event
  - ☞ Climatic factor
- Consider the variability in space of the leaching event
  - ☞ Soil factor
  - ☞ Crop factor
- Efficient in terms of numerical calculation
  - ☞ Limited to 8 contextual scenarios

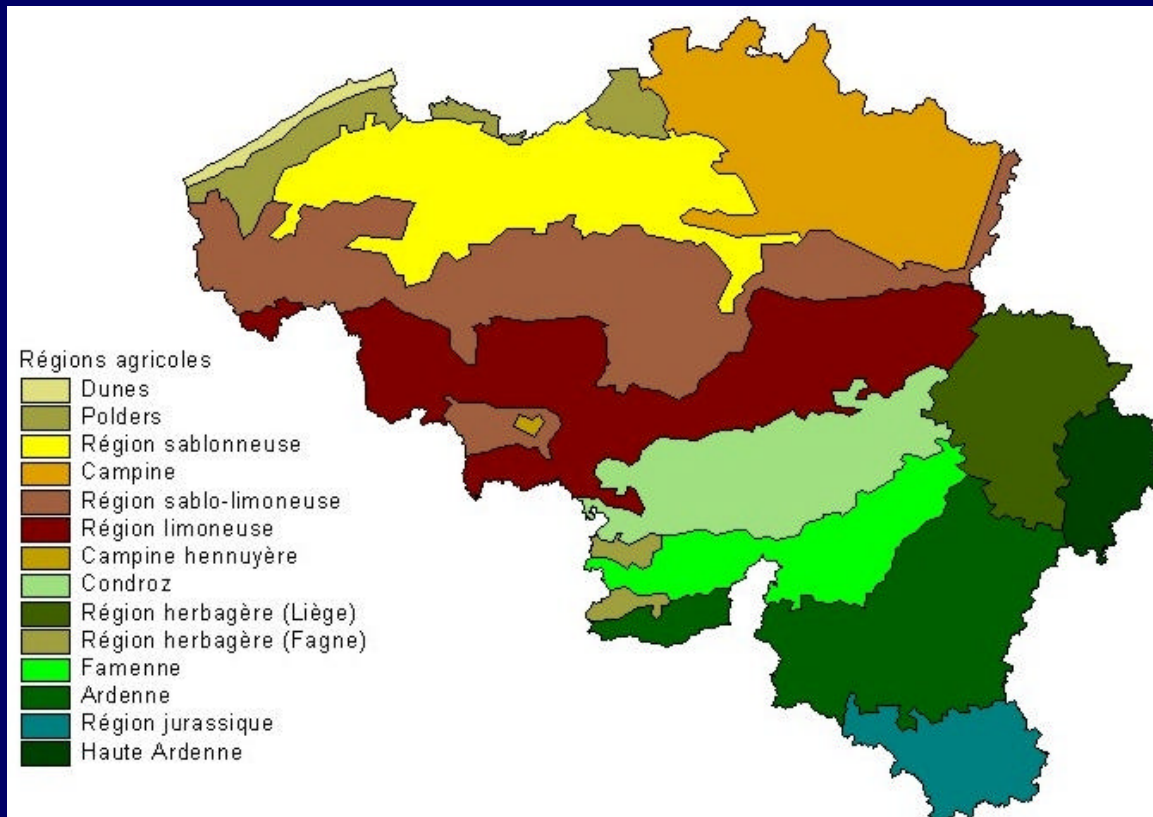
Design criteria: Consequences

- Only major agricultural areas are considered
- Only major crop rotations are considered
- Soils within the major agricultural areas have been selected using a representativity (mean) and vulnerability criteria
- Long term time series of climatic data have been considered allowing to consider representative (mean) and vulnerable time periods

Identification of the important AR ’s

4 AR ’s closely linked to the large soil associations

- Polders
- Sandy region
- Sandy loam region
- Loamy region



Remark

- Two minor agricultural regions were not selected sofar
  - Condroz
  - Ardennes
- Groundwater mask was not considered in the identification of the AR’s

Identification of agricultural rotations in the considered AR ’s

- Reference rotations
  - Polders : Beets - Winter wheat - Spring barley
  - Sableuse : Maize
  - Sablo-limoneuse : Potatoes - Maize - Winter wheat
  - Limoneuse : Beets - Winter wheat - Spring barley
- User specific rotations

Crop data

- For each crop :
  - Sowing date interval (p. ex. entre le 1/3 et le 30/4)
  - Mean length of the cropping season ⇨ Harvest date
  - Evolution of
    - KC
    - LAI
    - Rooting depth
  - Starting date of root inactivity
  - Parameters of the macroscopic root water uptake function.

Available crop data

- J.-F. Ledent (1996)
  - Sowing and harvest data, soil tillage practices
- Soltner (1990)
  - idem + evolution LAI and rooting depth
- MONICA
  - sowing and harvest dates for the central loamy belt, tillage practice, fertilisation practice
- SUCROS
  - Evolution of LAI and rooting depth

Crop data base

POMME DE TERRE

La culture n'est jamais semée avant le :	25-mars	
La culture n'est jamais semée après le :	05-mai	
Durée moyenne de culture :	183	jours

Evolution moyenne du LAI	nbre j. apr. semis	LAI
	0	0.3
	40	3
	61	3.5
	80	2.8
	135	0.4
	183	0

Evolution du facteur Kc	nbre j. apr. semis	Kc
	0	1
	70	1.05
	130	1.05
	183	0.7

Evolution moyenne de la profondeur d'enracinement :	nbre j. apr. semis	prof. enr. (mm)
	0	0
	40	600

Date du début d'inactivation des racines (en j apr. le semis)	183
Date d'inactivation maximum des racines (en j apr. le semis)	183

Paramètre de la fonction de puissement max des racines avec la prof.	pente (jour-1 mm-1)	intercept (jour-1)
	-2.20E-05	0.032

Availiable weather data

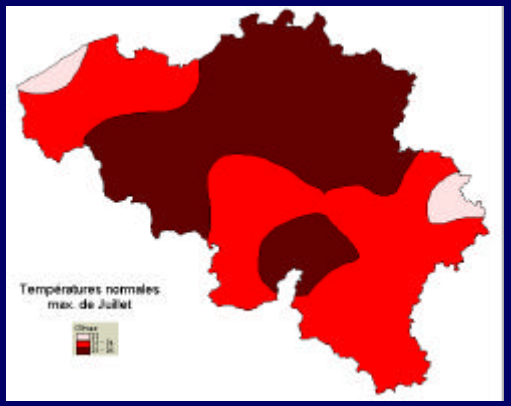
Royal Meteorological Institute

- Bulletins: Time series of daily meteorological data (MONICA)

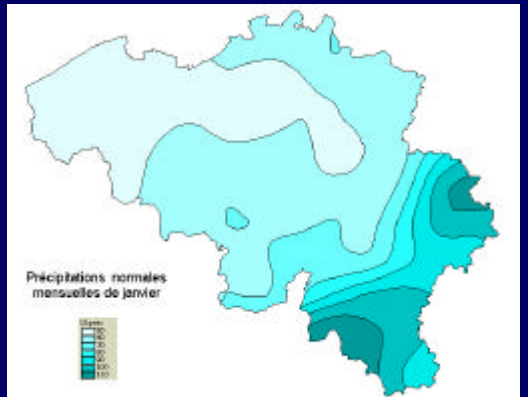
ISEPP average map data

Winter maximum temperature

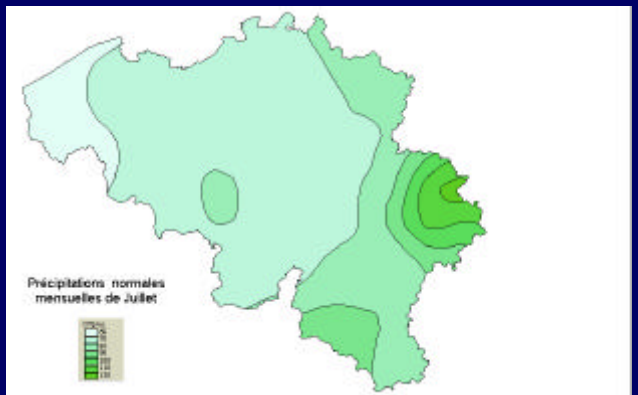
Summer maximum temperature



Winter precipitation



Summer precipitation



Climatic data implemented

30 year time series of the following daily data :

- T° min et T° max
- Precipitations
- ET0
- (Irrigation)

Scaling of the daily precipitation intensities in space using the monthly average maps

Climatic data

Available data in Uccle =>
Scaling factor

Précipitations

	Polders	Sableuse	Sablo-limoneuse	Limoneuse
Janvier	0.85	0.85	1	1
Février	0.9	0.9	0.95	1.05
Mars	0.9	0.9	0.95	1.05
Avril	0.85	0.88	0.95	1
Mai	0.85	0.9	0.95	1
Juin	0.85	1	1	1
Juillet	0.86	1	1	1
Août	0.85	0.9	1	1
Septembre	1	1.1	1.1	1.05
Octobre	0.9	0.9	1	0.95
Novembre	1	1	1	1.05
Décembre	0.9	0.9	1	1

T° min

	Polders	Sableuse	Sablo-limoneuse	Limoneuse
Janvier	1.5	0	0	0
Février	1.5	0	0	-1
Mars	2	0.5	0	0
Avril	0	0	0	0
Mai	-0.5	-0.5	-0.5	-1
Juin	-1.5	0	0	0
Juillet	-1.5	-1	0	-0.5
Août	-1.5	-0.5	0	1
Septembre	0	0	0	-0.5
Octobre	0	0	0	0
Novembre	1	0.5	0	-0.5
Décembre	1	0	0	-0.5

T° max

	Polders	Sableuse	Sablo-limoneuse	Limoneuse
Janvier	1.5	0	0	0
Février	1.5	0	0	0
Mars	0.5	0.5	0	0
Avril	0	0	0	0
Mai	-0.5	0	0	0
Juin	-1.5	0	0	0
Juillet	-1.5	-1	0	-0.5
Août	-1.5	-0.5	0	0
Septembre	0	0	0	-0.5
Octobre	0	0	0	0
Novembre	1	0.5	0	-0.5

Available soil data

- Soil maps
  - Soil association map (1/250.000)
  - IRSIA soil map (1/25.000)
- Soil data bases
  - AARDEWERK profil data base (8000 profiles)
  - AARDEWERK soil horizon data base (13000 horizon data)

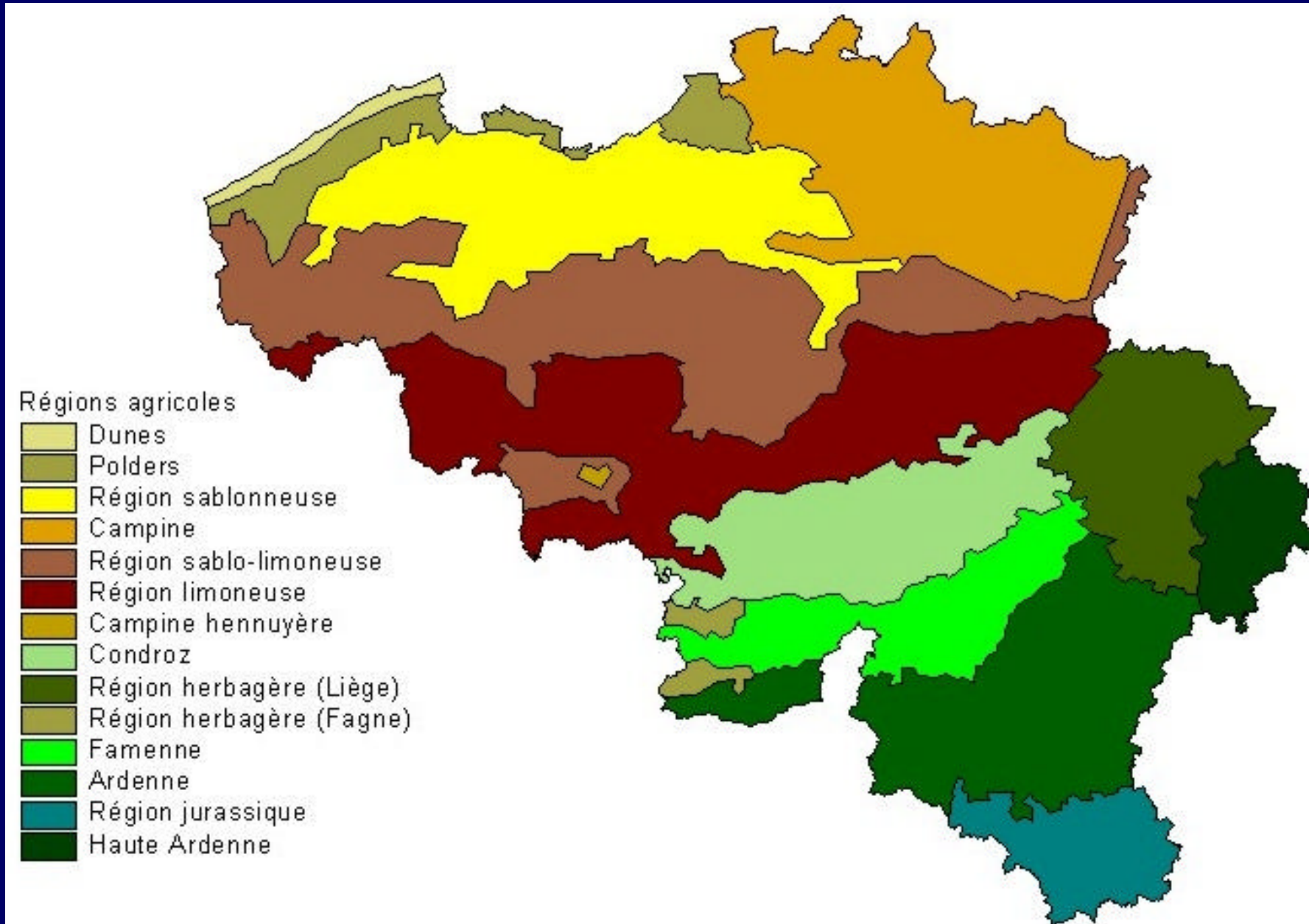
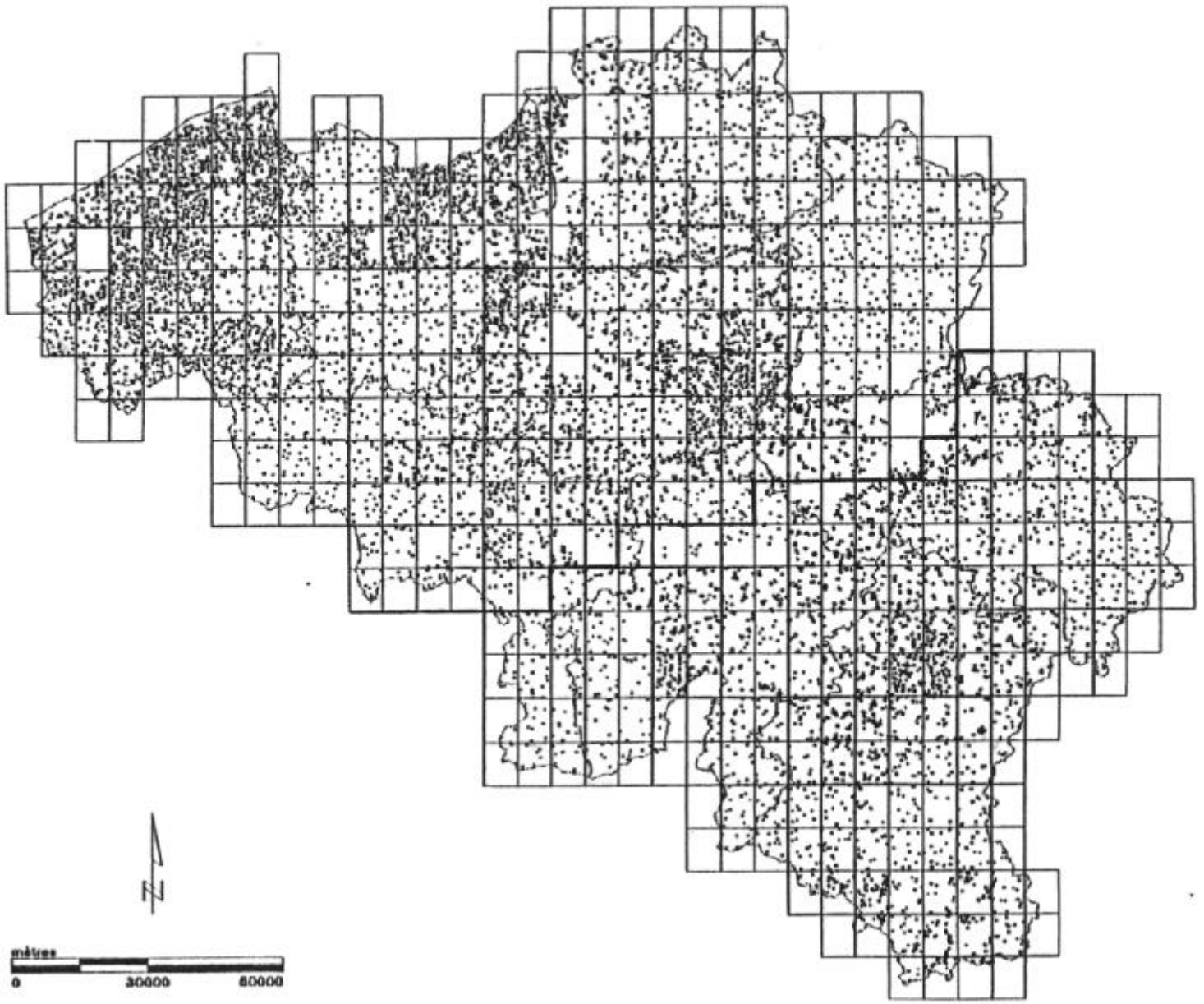

Régions agricoles
Dunes
Polders
Région sablonneuse
Campine
Région sablo-limoneuse
Région limoneuse
Campine hennuyère
Condroz
Région herbagère (Liège)
Région herbagère (Fagne)
Famenne
Ardenne
Région jurassique
Haute Ardenne

Figure 2: Distribution geographique des localisations de profil (Aardewerk)



Identification of the representative soil and the representative-vulnerable soil in each AR

- Definition of a representativity index REP

  REP = Occurrence of a certain soil type, characterised by its soil serie in the soil profile data base for each agricultural area

- Definition of the vulnerability index for pesticide leaching VUL

  VUL = Calculated Attenuation Factor for each soil serie for 4 pesticides (FOCUS sampling pesticides) and 3 rainfall surplus amounts

- Define representativity and vulnerability index

  REP_VUL = REP * VUL

Identification of the representative soil and the representative-vulnerable soil in each AR

$$AF = \exp\left(\frac{-0.693 \cdot d \cdot RF \cdot q_{fc}}{q \cdot t_{1/2}}\right)$$

$$RF = 1 + \left(\frac{\rho_b \cdot f_{oc} \cdot K_{oc}}{\theta_{fc}}\right) + \left(\frac{n \cdot K_H}{\theta_{fc}}\right) - K_H$$

Identification of the representative soil and the representative-vulnerable soil in each AR

Component	Symbol	Significance	Units	Estimation method
Hydrogeology	d	Mean depth to the groundwater body	m	Soil drainage class
Soil	θfc	Volumetric moisture content at field capacity	-	Pedotransfer functions of Vereecken et al., 198
	foc	Fraction of the organic carbon	-	Soil horizont data base
	ρb	Soil bulk density	kg/m3	Pedotransfer function of Adams (1973)
	n	Soil total porosity	-	Pedotransfer functions of Vereecken et al., 198
Climate	q	Mean annual recharge	m/year	3 levels
Pesticide	koc	Carbon partitioning coefficient	m3/kg	FOCUS sample pesticides
	kH	Henry's constant	-	FOCUS sample pesticides
	t1/2	Half life time	year	FOCUS sample pesticides

Identification of the representative soil and the representative-vulnerable soil in each AR

Region	Representative	Vulnerable-representative
Polders	Sdpz0	Shpz0
Sandy	Zcg(o)	Zdg(o)
Sandy-loam	Lda0	wLhc2
Loam	Aba1	Aha0

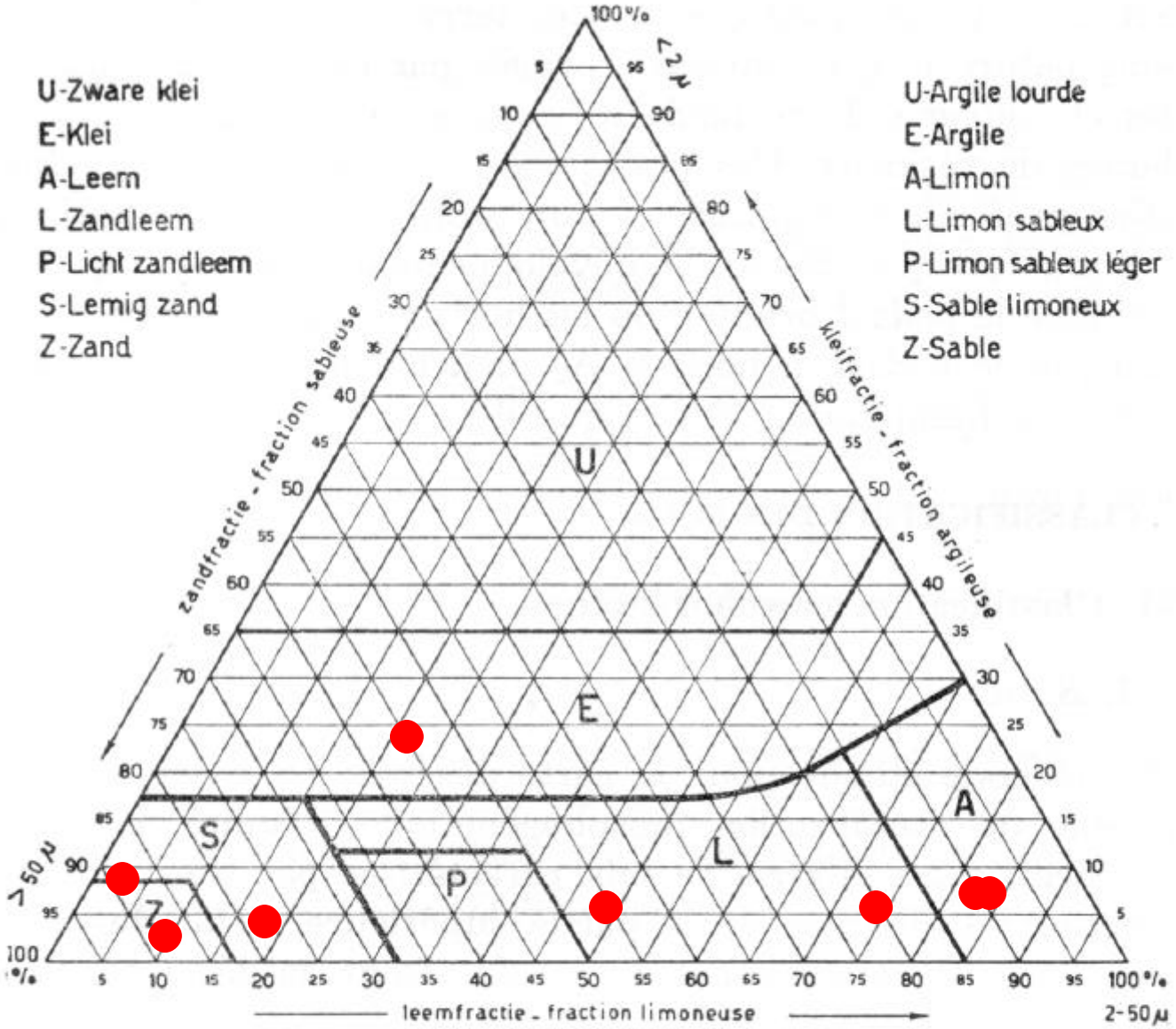
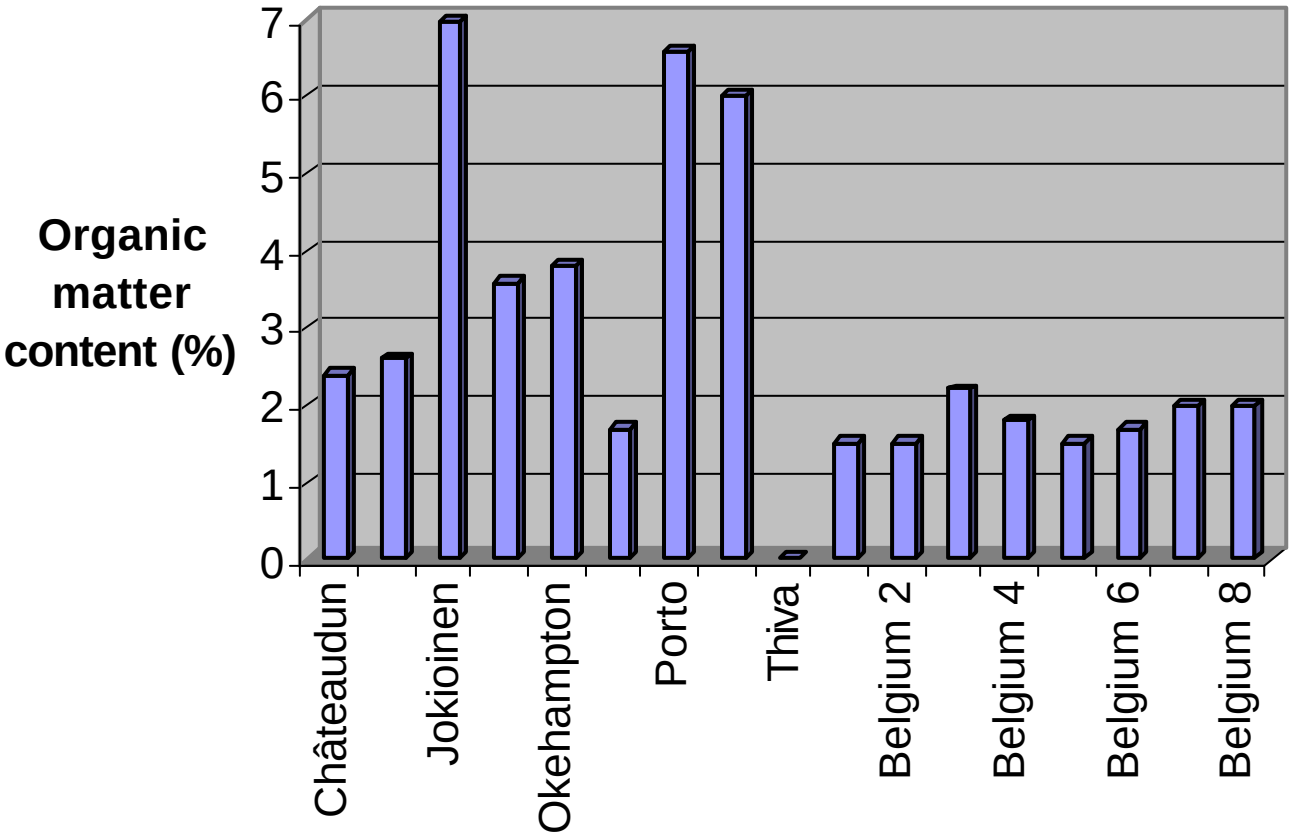
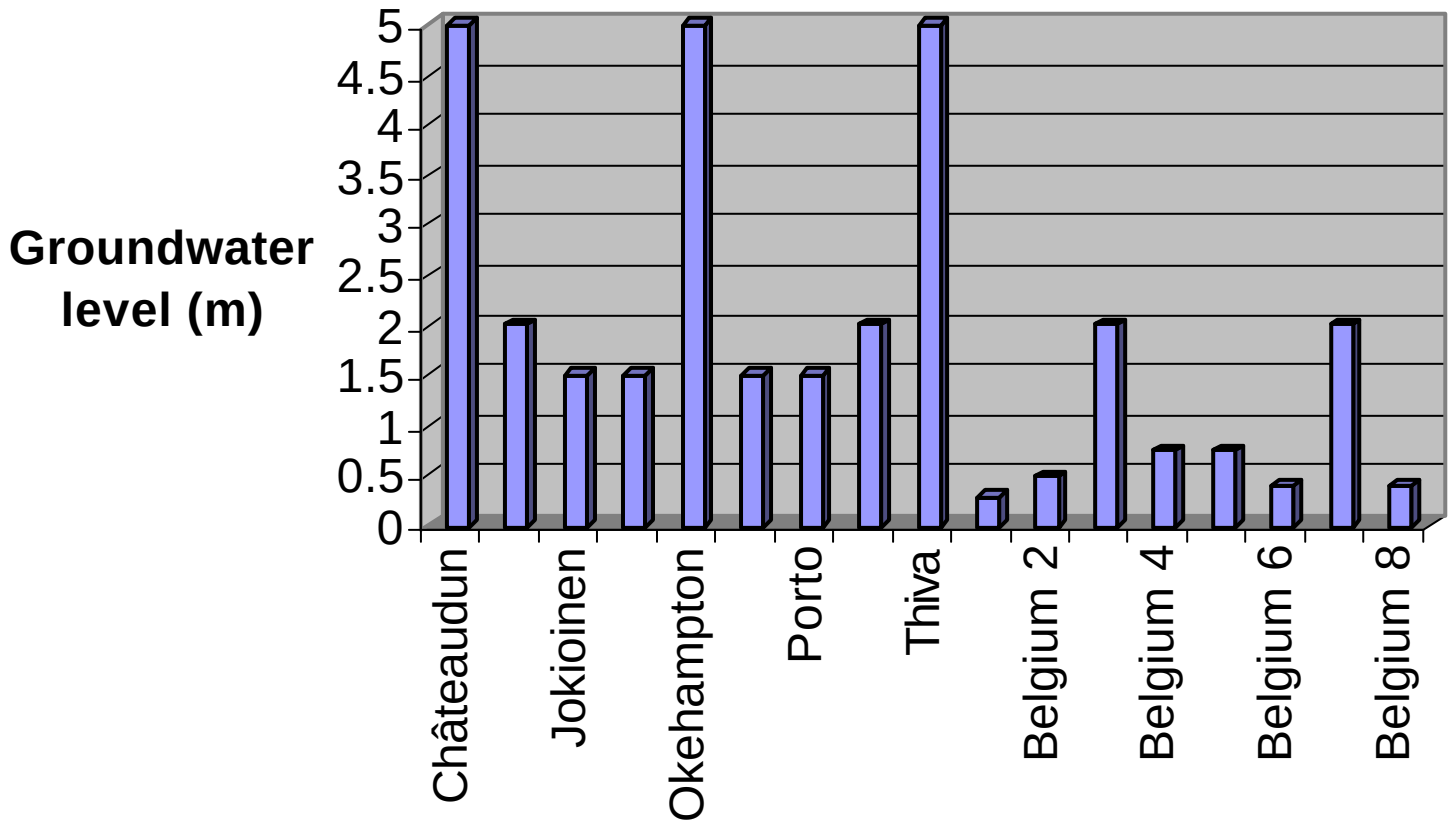


Fig. 2.

Diagramme triangulaire des classes texturales.

Textuurklassendriehoeksgrafiek.


Organic matter content (%)
0
1
2
3
4
5
6
7
Châteaudun
Jokioinen
Okehampton
Porto
Thiva
Belgium 2
Belgium 4
Belgium 6
Belgium 8


Groundwater level (m)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Châteaudun
Jokioinen
Okehampton
Porto
Thiva
Belgium 2
Belgium 4
Belgium 6
Belgium 8

Summary: Belgian contextual scenarios

- Reference scenarios
  - ▲ 4 agricultural regions (AR ’s)
  - ▲ 2 soil types for each agricultural region
  - ▲ 1 reference rotation for each region
  - ▲ 1 weather scenario for each region
  - ☛ 8 reference scenarios
- Alternative scenarios
  - ▲ User dependent crop rotation for each soil region

Implementation of the DSS

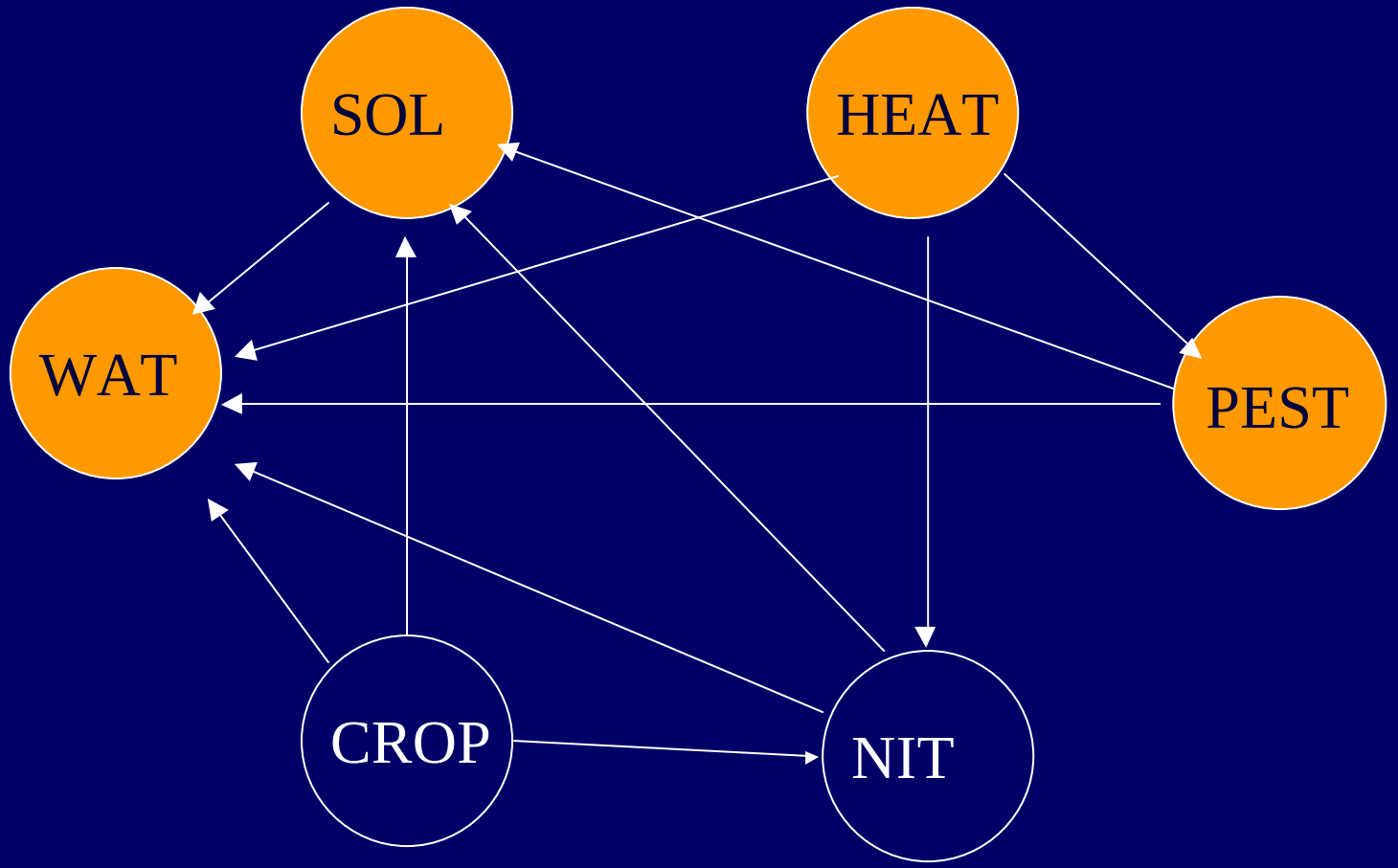
Design criteria

- Belgian contextual scenario’s should be considered
- Using a maintained and preferably well validated leaching model for the Belgian conditions
- Documented – transparent risk assessment procedure

The 'pesticide leaching model': WAVE (Water and Agrochemicals in soil and Vadose Environment) model

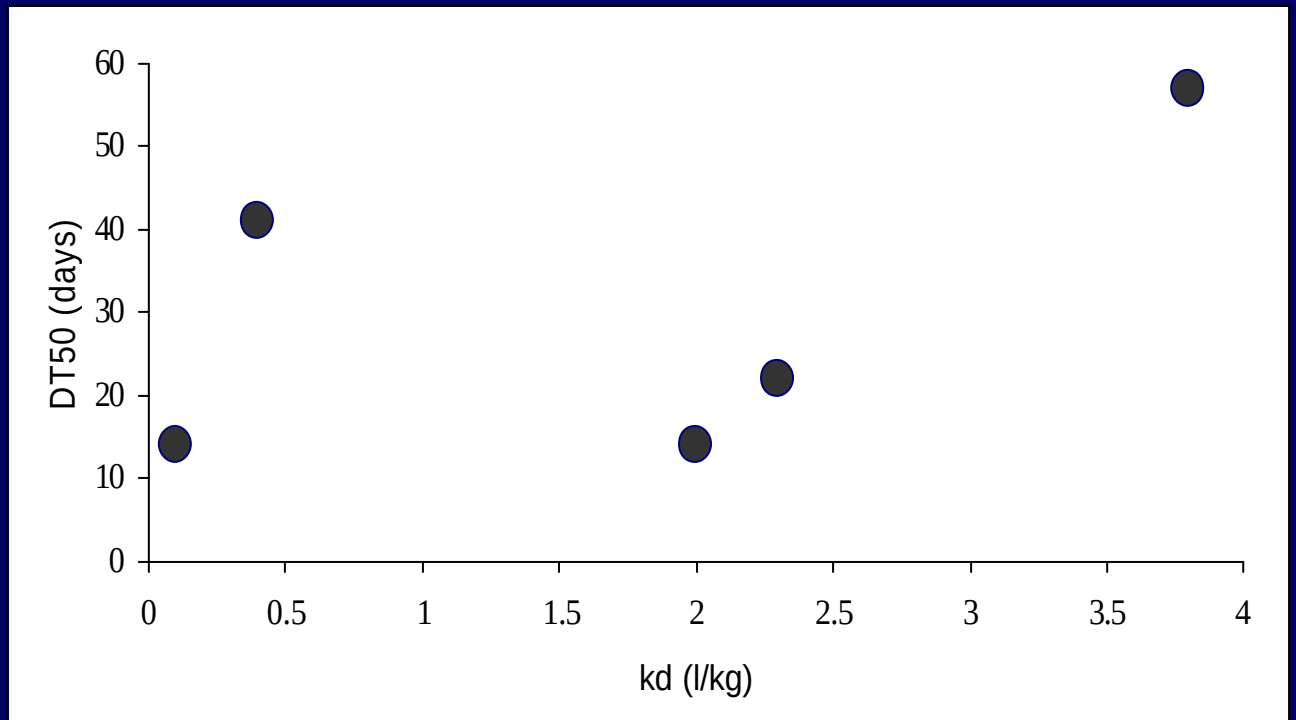
- Water transport in soil
- Solute transport in soil
- Heat transport in soil
- Crop growth
- Nitrate fate and transport in soil
- Pesticide fate and transport in soil

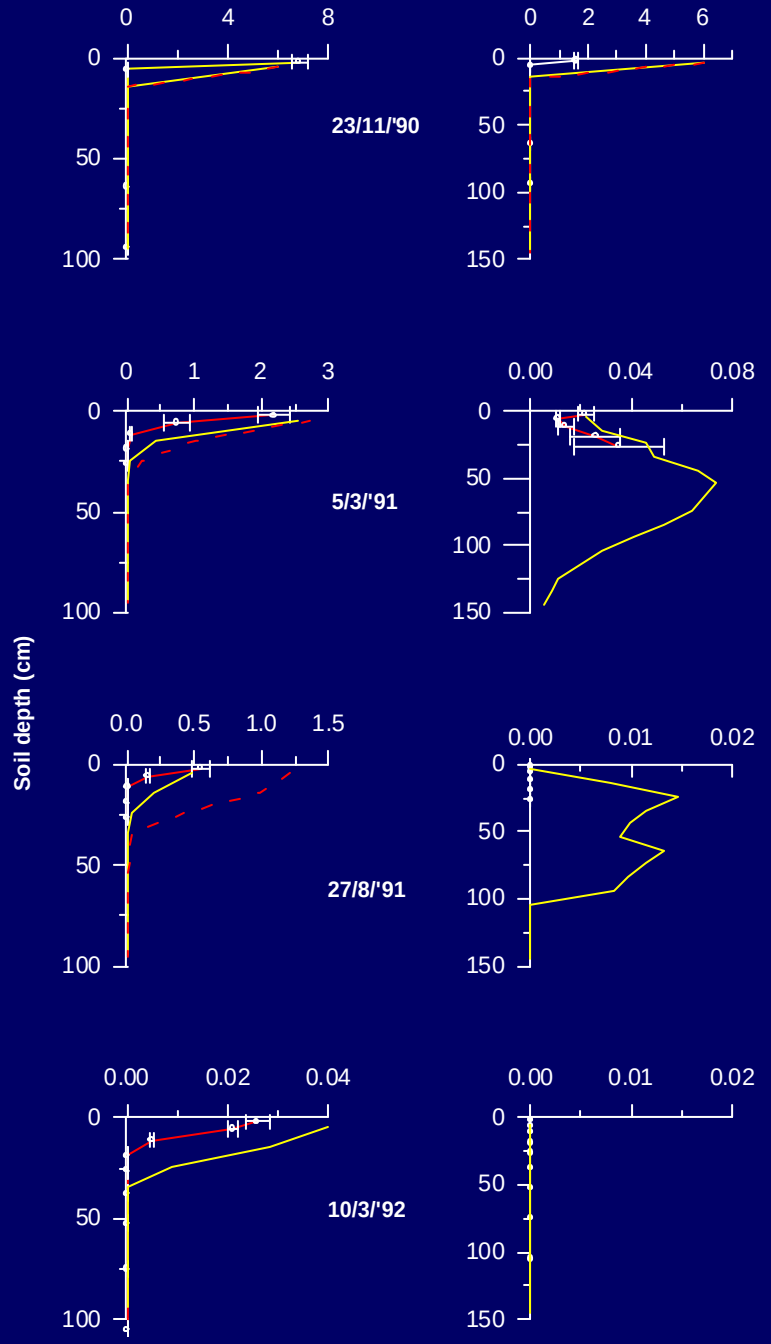
The WAVE modules

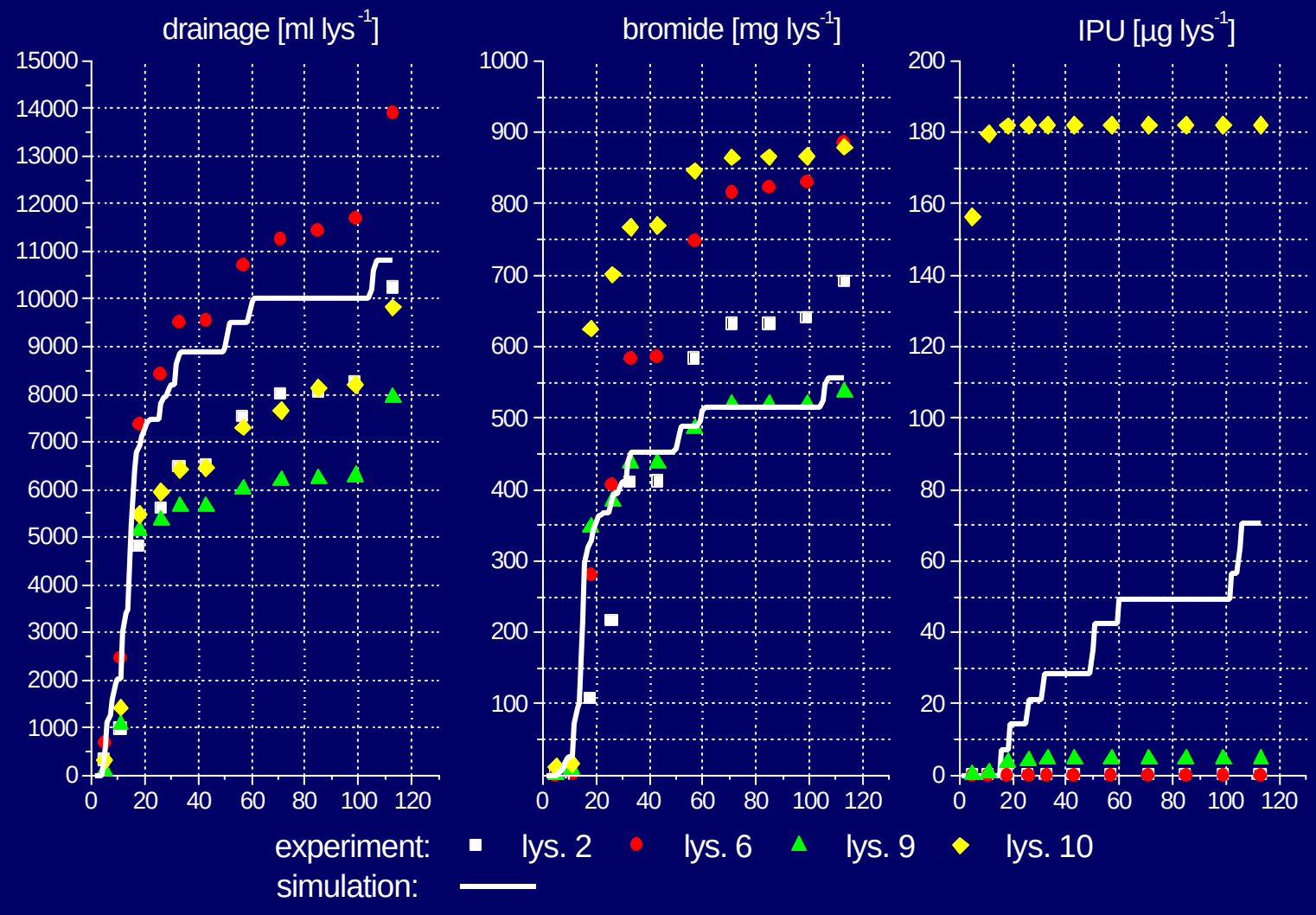


Validation status related to the pesticide leaching component

Product	kd (l/kg)	Dt50 (days)	Crop	Soil	Site	Reference
Clopyralid	0.4	41	Oil seed rape	Loam	Lysimeter	Dust, 1995
Metabenzthiazuron	2.3	22	Winter wheat	Loam	Lysimeter	Vereecken et al., 1994
Bentazone	0.1	14	Musterd	Sand	Field	Vanclooster et al., 2000
Ethorprophos	3.8	57	Musterd	Sand	Field	Vanclooster et al., 2000
Isoproturon	2	14	Winter wheat	Loam	Lysimeter	Vanclooster et al., 2000

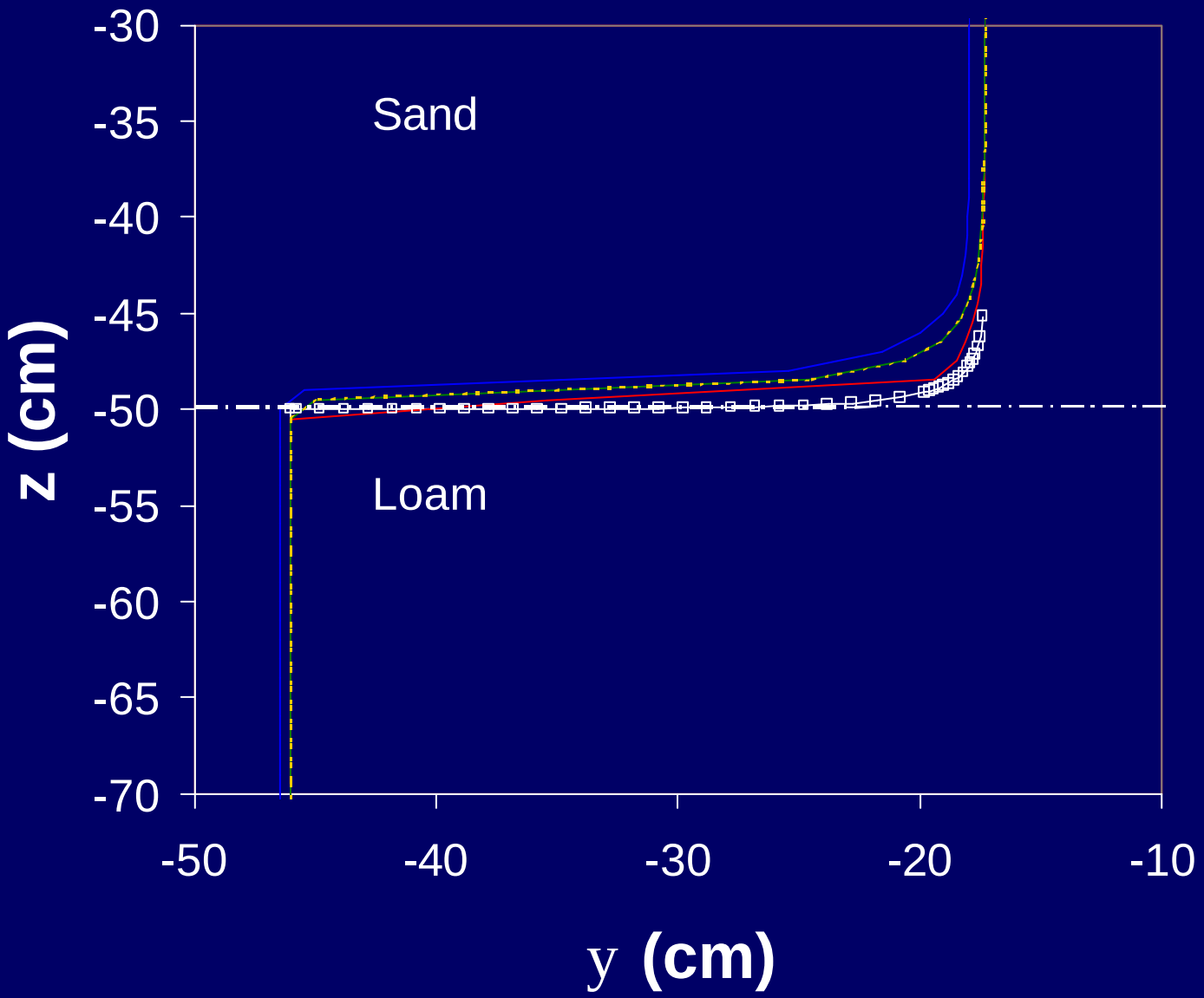



Soil depth (cm)
0
4
8
0
50
100
23/11/'90
0
2
4
6
0
50
100
150
0
1
2
3
0
50
100
5/3/'91
0.00
0.04
0.08
0
50
100
150
0.0
0.5
1.0
1.5
0
50
100
27/8/'91
0.00
0.01
0.02
0
50
100
150
0.00
0.02
0.04
0
50
100
10/3/'92
0.00
0.01
0.02
0
50
100
150

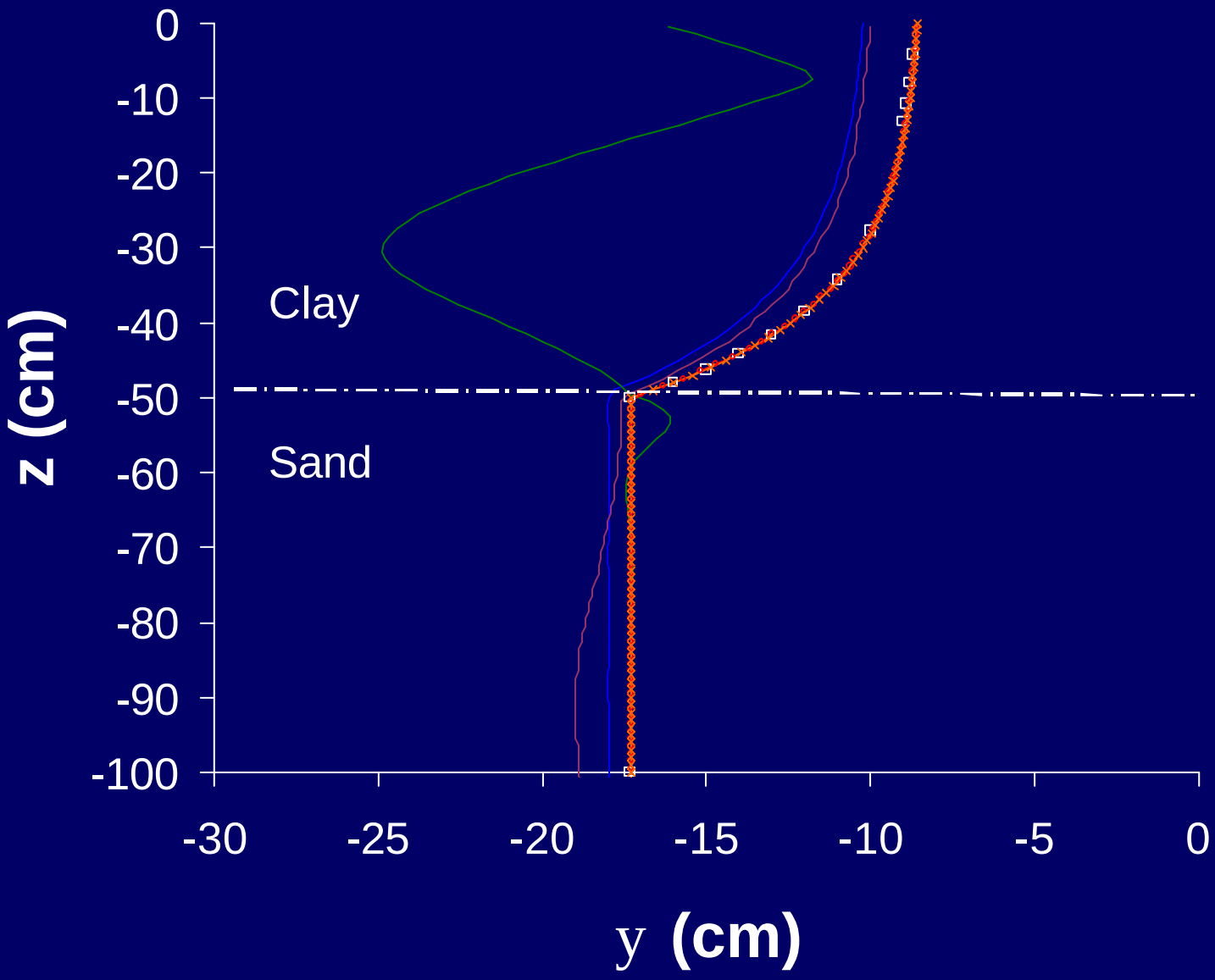

drainage [ml lys-1]
bromide [mg lys-1]
IPU [µg lys-1]
experiment:
lys. 2
lys. 6
lys. 9
lys. 10
simulation:

Why WAVE-model?

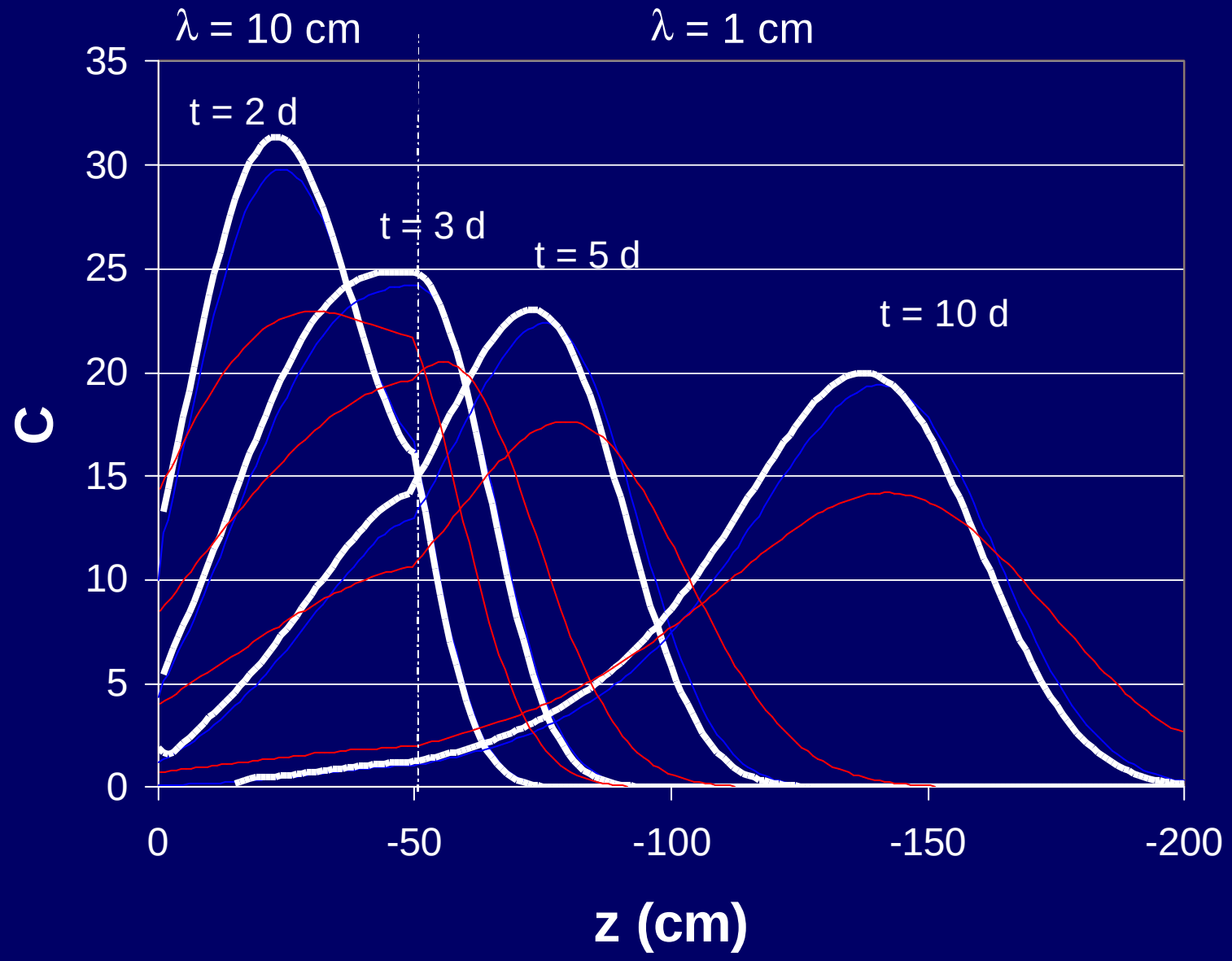
- Water and crop component well validated for the Belgian conditions, in particular in relation to nutrient emissions
- Possibility to implement quality control
- Possibility for model refinement
- Differences with other reference models (e.g. PEARL) could be considered as acceptable



From Vanderborght et al., 20



From Vanderborght et al., 20



From Vanderborght et al., 20

- FOCUS Dummy Pesticide A:
  - DT50 = 60 d (@ 20°C)
  - Koc = 103 mL/g (1/n = 1)
  - Application: 1 kg/ha @ end of October

Scenario		Concentration in µg/L PELEP (90'er Perc.)	PEARL (90'er Perc.)
Sand	rep	27.9	19.5
	vul	47.2	29.7
Loam	rep	17.0	36.5
	vul	30.2	40.7
Sandy Loam	rep	28.2	43.3
	vul	60.1	35.8
Polder	rep	13.4	22.6
	vul	33.6	31.6
	Min.	13.4	19.5
	Max.	60.1	43.3

From Shäfer, 2002

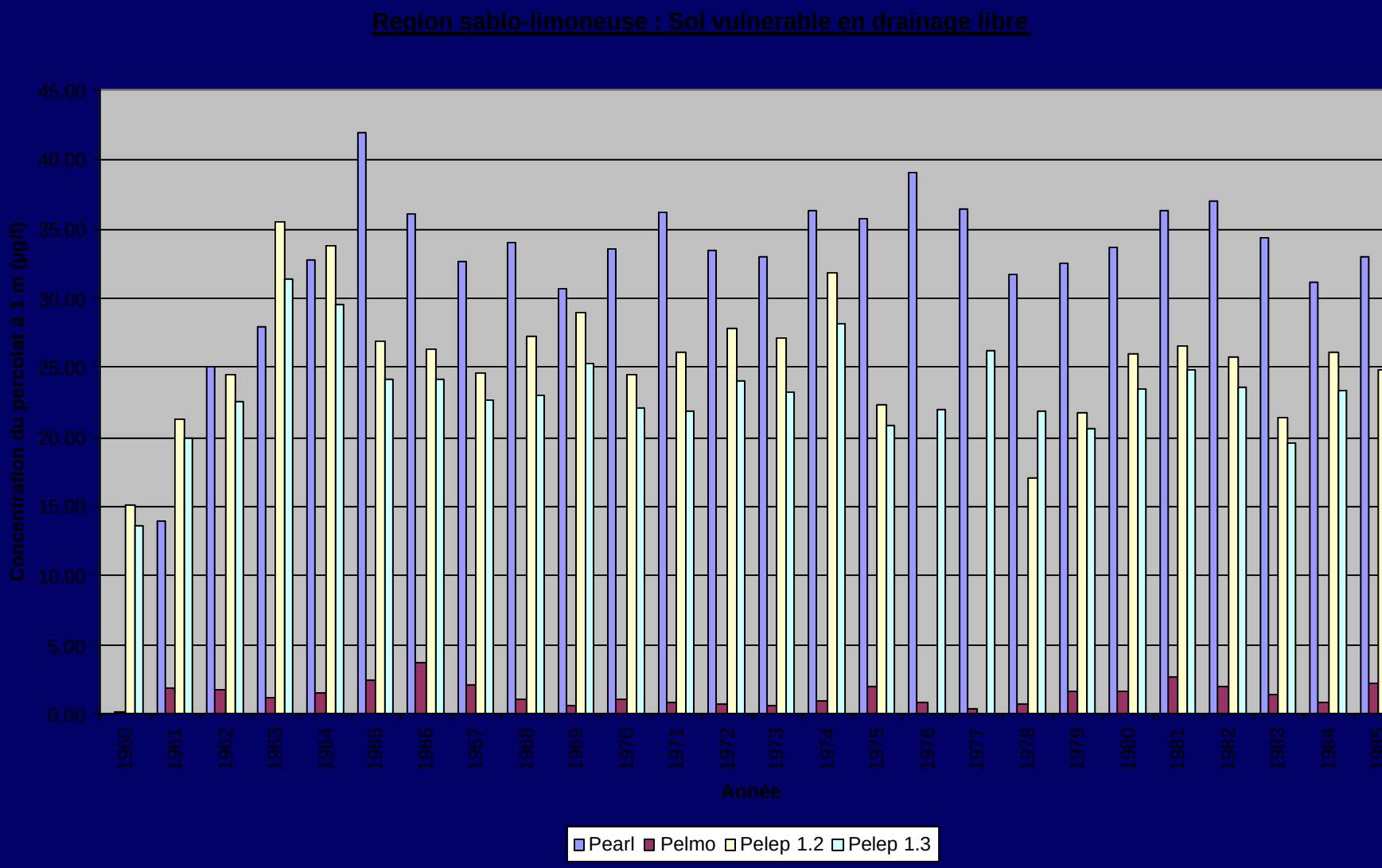
- FOCUS Dummy Pesticide D:
  - DT50 = 20 d (@ 20°C)
  - Koc = 60 mL/g (1/n = 1)
  - Application: 1 kg/ha @ end of October

Scenario		Concentration in µg/L PELEP (90'er Perc.)	PEARL (90'er Perc.)
Sand	rep	10.6	4.9
	vul	24.3	17.3
Loam	rep	4.4	13.8
	vul	13.4	19.8
Sandy Loam	rep	12.0	19.0
	vul	28.0	16.7
Polder	rep	4.2	4.3
	vul	13.6	15.1
	Min.	4.2	4.3
	Max.	28.0	19.8

From Shäfer, 2002

- Monoculture of mais
  - Sowing date: 1 May; Emergence: 20 May; Harvest: 31 October
- 4 representative and 4 vulnerable soils
- Pesticide ‘ A-FOCUS ’
  - koc = 103 dm^3/kg; DT50 = 60 days
- Application date = 1 May (Sowing)
- Application dose = 1 kg/ha
- Long term climatic scenario (26 Belgian climatic data files)
- Output value: mean yearly concentration of the leachate at 1 m depth (ppb)

From Argeles, 2002


Region sablo-limoneuse : Sol vulnerable en drainage libre
Concentration du percolat à 1 m (µg/l)
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
Année
Pearl
Pelmo
Pelep 1.2
Pelep 1.3

	PELEP	PEARL	PELMO
Moyenne	24.39	12.01	3.29
Mediane	24.39	12.10	3.23
Percentile 90	28.30	16.09	4.86
Ecart-type	3.93	3.83	1.43

Implementation of the DSS

- EXCEL
  - Data base management
  - Input-output functioning
- PERL
  - Coupling WAVE input charts
- WAVE:
  - 1 crop
  - 365 days

PEC groundwater?

Simulated daily water drainage: Jw,i

Simulated daily pesticide leaching: Js,i

$$\text{mean\_maximum\_concentration} = \text{mean}_j\left(\left(\max_i(Js/Jw)\right)\right), \quad i = 1,2 \text{ or } 3*365,\ j = 30$$

$$\text{percentile\_maximum\_concentration} = \text{percentile}_j\left(\left(\max_i(Js/Jw)\right)\right), \quad i = 1,2 \text{ or } 3*365,\ j = 30$$

$$\text{mean\_fraction\_leached} = \text{mean}_j\left(\frac{\sum_i Js,i}{\sum_j Ja,k}\right), \quad i = 1,2 \text{ or } 3*365;\ j = 30;\ k = \text{number of applications}$$

$$\text{percentile\_fraction\_leached} = \text{percentile}_j\left(\frac{\sum_i Js,i}{\sum_j Ja,k}\right), \quad i = 1,2 \text{ or } 3*365;\ j = 30;\ k = \text{number of applicati}$$

$$\text{mean\_mean\_concentration} = \text{mean}_j\left(\sum_i Js,i / \sum_i Jw,i\right), \quad i = 1,2 \text{ or } 3*365,\ j = 30$$

$$\text{percentile\_mean\_concentration} = \text{percentile}_j\left(\sum_i Js,i / \sum_i Jw,i\right), \quad i = 1,2 \text{ or } 3*365,\ j = 30$$

PEC_groundwater

Overview
Version 1.3.2
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PELEP-DSS

(Pesticide Leaching Estimator and Predictor)

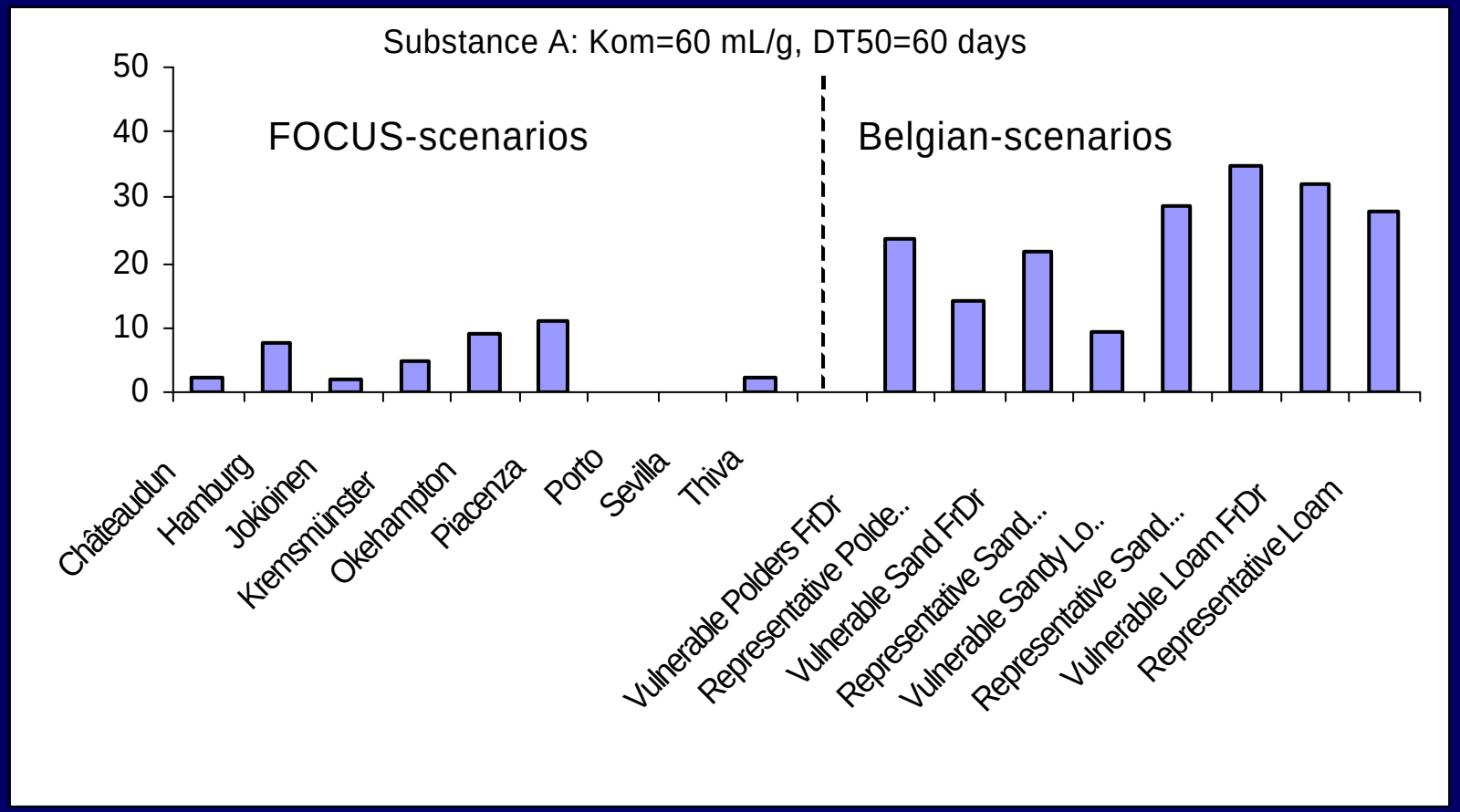
Welcome to the home page of PELEP-DSS. You can download from this website the currently approved version of the Pelep-DSS, which is used by the Belgian Ministry of Agriculture for the registration of plant protection products.

UCL-Département des Sciences du Milieu et de l'Aménagement du Territoire-Unité de génie rural (GERU)

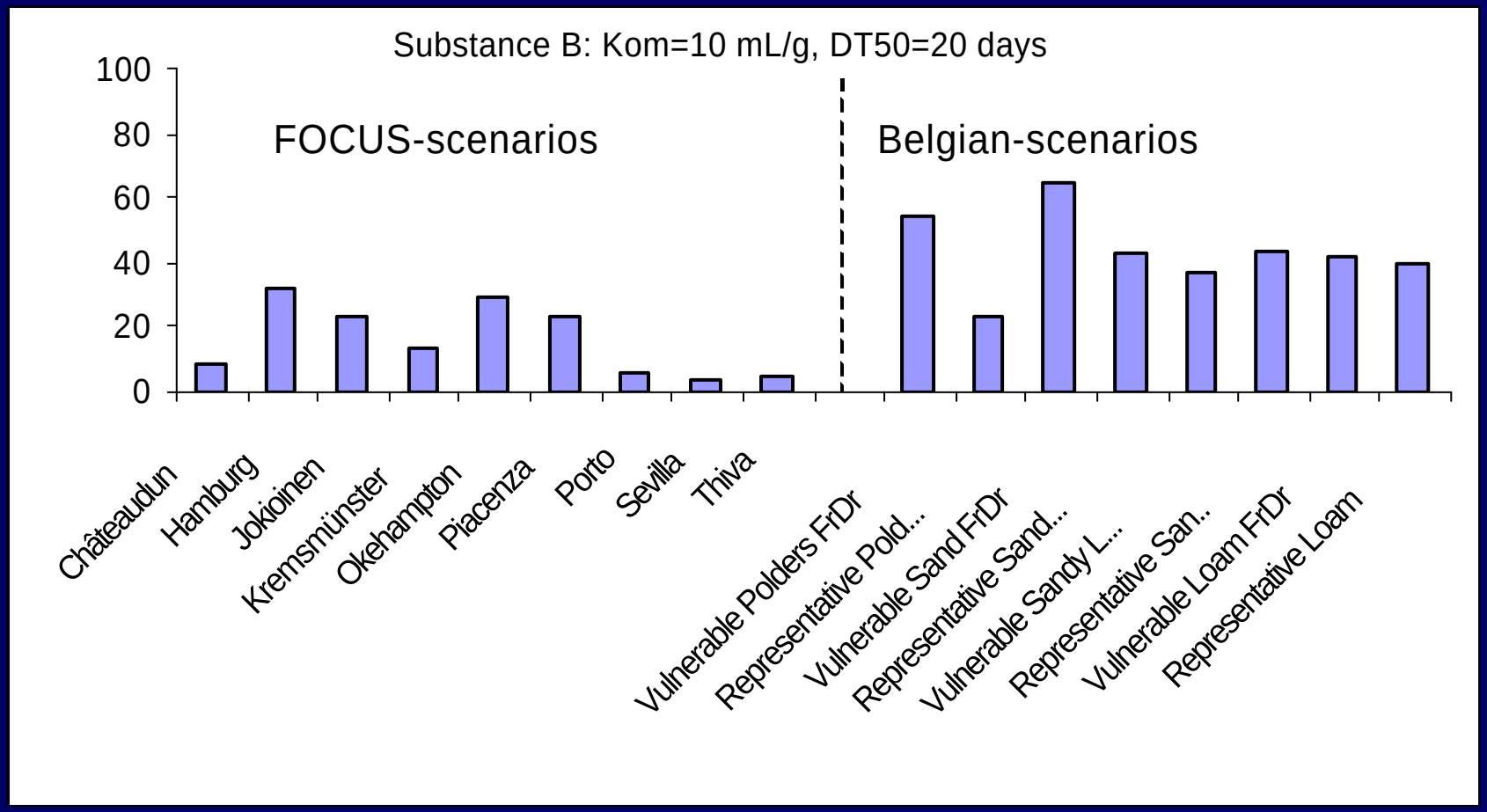
Ministère des Classes Moyennes et de l'Agriculture-DG4

This Site is optimised for Internet Explorer 5.0

Some experiences



From Jene, 2002



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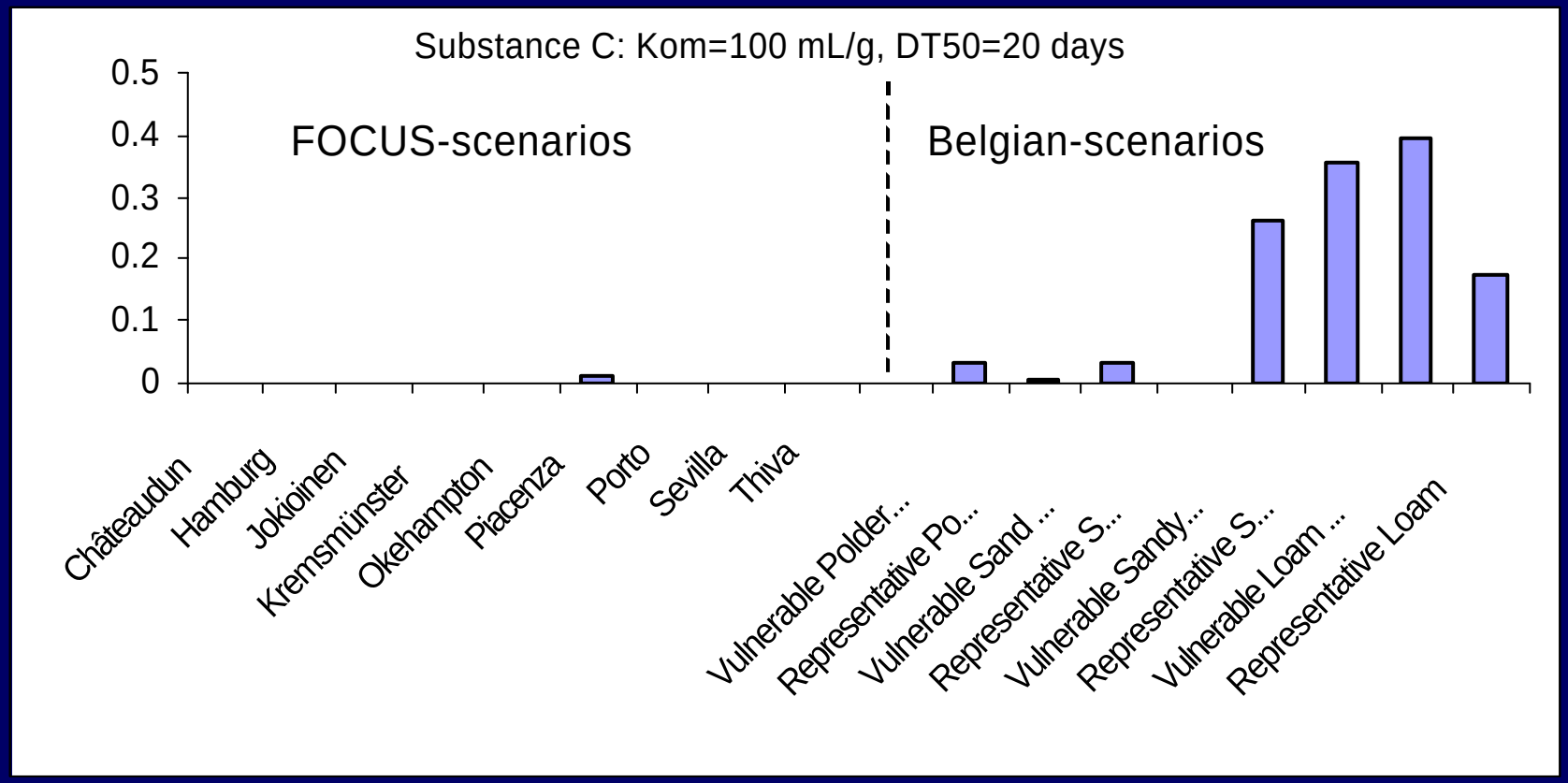
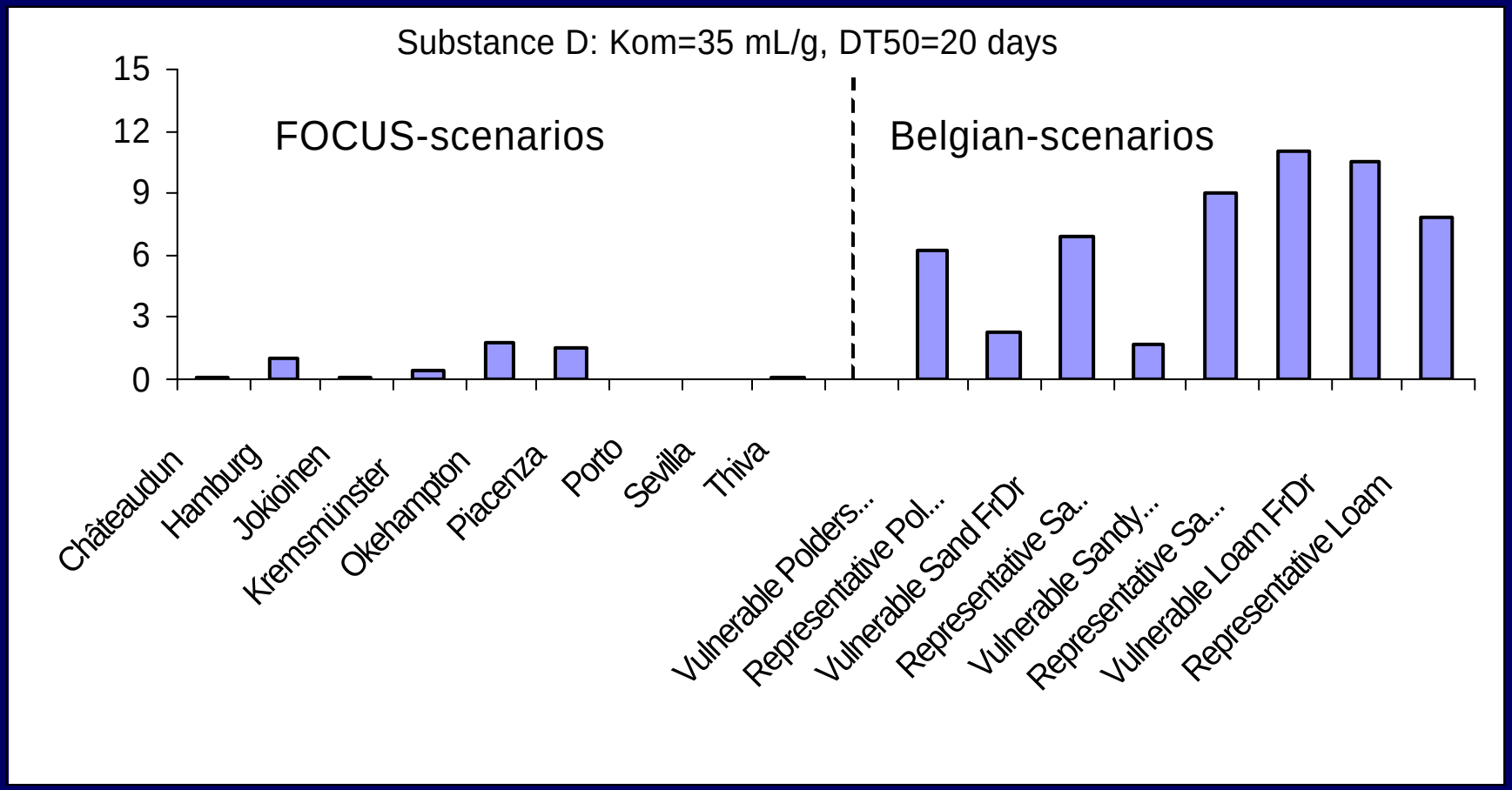


From Jene, 2002



From Jene, 2002