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DRAFT REPORT OF THE JOINT OECD/EC SEMINAR ON HARMONISED ENVIRONMENTAL INDICATORS FOR PESTICIDE RISK (HAIR)

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Series on Pesticides

No. 40

Report of the Joint OECD Pesticide Risk Reduction Steering Group / EC-HAIR Seminar on Harmonised Environmental Indicators for Pesticide Risk

IOMC

INTER-ORGANISATION PROGRAMME FOR THE SOUND MANAGEMENT OF CHEMICALS

A cooperative agreement among

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No. 33 *Overview of Country and Regional Review Procedures for Agricultural Pesticides and Relevant Documents*
No. 34 *Frequently Asked Questions about Work Sharing on Pesticide Registration Reviews*
No. 35 *Report of the OECD Pesticide Risk Reduction Steering Group Seminar "Pesticide Risk Reduction through Better Application Technology"*
No. 36 *Analysis and Assessment of Current Protocols to Develop Harmonised Test Methods and Relevant Performance Standards for the Efficacy Testing of Treated Articles/Treated Materials*
No. 37 *Report on the OECD Pesticide Risk Reduction Steering Group Workshop "Pesticide User Compliance'*
No. 38 *Survey of the Pesticide Risk Reduction Steering Group on Minor Uses of Pesticides*
No. 39 *Guidance Document on Pesticide Residue Analytical Methods*

Published separately

OECD Guidance for Country Data Review Reports on Plant Protection Products and their Active Substances-Monograph Guidance (1998, revised 2001, 2005)

OECD Guidance for Industry Data Submissions on Plant Protection Products and their Active Substances-Dossier Guidance (1998, revised 2001, 2005)

Report of the Pesticide Aquatic Risk Indicators Expert Group (2000)

ABOUT THE OECD

The Organisation for Economic Co-operation and Development (OECD) is an intergovernmental organisation in which representatives of 30 industrialised countries in North America, Europe and the Asia and Pacific region, as well as the European Commission, meet to co-ordinate and harmonise policies, discuss issues of mutual concern, and work together to respond to international problems. Most of the OECD's work is carried out by more than 200 specialised committees and working groups composed of member country delegates. Observers from several countries with special status at the OECD, and from interested international organisations, attend many of the OECD's workshops and other meetings. Committees and working groups are served by the OECD Secretariat, located in Paris, France, which is organised into directorates and divisions.

The Pesticide Programme was created in 1992 within the OECD's Environmental Health and Safety Division to help OECD countries:

- harmonise their pesticide review procedures,
- share the work of evaluating pesticides, and
- reduce risks associated with pesticide use.

The Pesticide Programme is directed by the Working Group on Pesticides, composed primarily of delegates from OECD Member countries, but also including representatives from the European Commission and other international organisations (*e.g.* United Nations Food and Agriculture Organization, United Nations Environment Programme, World Health Organization, Council of Europe), and observers from the pesticide industry and public interest organisations (NGOs).

The Environment, Health and Safety Division publishes free-of-charge documents in ten different series***:*** **Testing and Assessment; Good Laboratory Practice and Compliance Monitoring; Pesticides and Biocides; Risk Management; Harmonisation of Regulatory Oversight in Biotechnology; Safety of Novel Foods and Feeds; Chemical Accidents; Pollutant Release and Transfer Registers; Emission Scenario Documents; and the Safety of Manufactured Nanomaterials.** More information about the Environment, Health and Safety Programme and EHS publications is available on the OECD's World Wide Web site (http://www.oecd.org/ehs/).

This publication was produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals (IOMC). It was approved for derestriction by the Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, the governing body of the Environment, Health and Safety Division.

The Inter-Organization Programme for the Sound Management of Chemicals (IOMC) was established in 1995 by UNEP, ILO, FAO, WHO, UNIDO and the OECD (the Participating Organizations), following recommendations made by the 1992 UN Conference on Environment and Development to strengthen co-operation and increase international co-ordination in the field of chemical safety. UNITAR joined the IOMC in 1997 to become the seventh Participating Organization. The purpose of the IOMC is to promote co-ordination of the policies and activities pursued by the Participating Organizations, jointly or separately, to achieve the sound management of chemicals in relation to human health and the environment.

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Introduction

This report presents the results of a joint OECD/EC seminar on the development of harmonised environmental indicators for pesticide risk. The seminar was held on 13 November 2006 in Bonn (Germany).

This seminar is one in a series of seminars and workshops organised by the OECD Pesticide Risk Reduction Steering Group, a sub-group of the OECD Working Group on Pesticides. The seminars focus on key issues in pesticide risk reduction of concern to OECD governments. The seminars are intended to provide an opportunity for OECD governments to discuss the issues together and with non-governmental stakeholders.

The OECD Pesticide Risk Reduction Steering Group has been working on pesticide risk indicators since the middle of the 1990's and held its first workshop on the issue in 1997. It has published several reports on this issue, in particular: the *Summary Report of the OECD Project on Pesticide Aquatic Risk Indicators* (2002) and the *Summary Report of the OECD Project on Pesticide Terrestrial Risk Indicators (TERI)* (2004).

The aims of this seminar were to:

- present the indicators developed in the framework of the EC-funded HAIR project (HArmonised environmental Indicators for pesticide Risk),
- discuss issues related to further developments, and
- consider ways of broadening the use of these indicators across OECD Member countries.

Participants

Seventy-one people attended the seminar, including:

- representatives of the pesticide regulatory authorities of Australia, Belgium, Canada, Czech republic, Denmark, Germany, Hungary, Ireland, Italy, Japan, Mexico, the Netherlands, New Zealand, Switzerland, the United Kingdom, and the United States
- officials from the European Commission Directorate-General for Environment, for Health and Consumer Protection, for Research, for Statistics, from the European Commission Joint Research Centre and from the European Food safety Authority
- officials from the U.N. Food and Agricultural Organization (FAO)
- representatives of CropLife International (the international association of pesticide manufacturers) and of the Business and Industry Advisory Committee to OECD (BIAC)

A participants list is attached in Annex 1.

Structure of the seminar

The first part of the seminar was devoted to the presentation of the HAIR project design and functionality, with respect to:

- data necessary for calculating indicators;
- how the various indicators have been developed (aquatic, terrestrial, groundwater, consumer and worker indicators).

The second part of the seminar was devoted to discussion and conclusions that are presented below.

The agenda of the seminar is available in Annex 2.

The HAIR project

The HAIR project will support Community policies for sustainable agriculture by providing a harmonised European approach for indicators of the overall risk of pesticides. It will integrate European scientific expertise on the use, emissions and environmental fate of pesticides and their impact on agro-ecosystems and human health. This will contribute directly to the 6th Environment Action Programme Thematic Strategy on the Sustainable Use of Plant Protection Products.

The main deliverable of the project is a set of harmonised environmental and human health risk indicators, implemented in an easy to use software package. The tool will include methods to predict environmental fate and exposure, and the resulting acute and chronic risks:

- for aquatic and terrestrial organisms
- for groundwater
- for public health (including pregnant women) and
- for applicators of the pesticides

Databases will be developed for pesticide use, agricultural practice, land use, GIS information and eco-toxicological data.

The project started in January 2003 and will be completed in March 2007.

Discussion

The following questions guided the discussion:

- What is the depth we would like to achieve in developing indicators?
- How can we develop indicators that give both broad applicability and also greater depth?
- In what way can HAIR be the solution?
- Is HAIR a tool that could be used outside the EU?

- How could HAIR be adapted for greater value?
- What are the next steps for further development of these indicators?

Highlights

As most of the seminar was devoted to presentations, there was only limited time for a round-table discussion. The main conclusions from this discussion follow.

Several Delegates highlighted important elements which should be considered both in the further development of HAIR, as well as any other work on indicators.

First, when developing a set of indicators, a central question to consider is who the audience will be, and how they will use it. That is, indicators which can provide information for politicians may be different from indicators used by risk assessors and risk managers. Indicators can be very simple or complex, and the level of complexity of each indicator will affect how (and by whom) it is used.

Second, given the number of scientific assumptions that are inherent in the design of indicators, the validation of the indicators is crucial if they are to be accepted and used. This is particularly important with respect to aggregations. If the current HAIR project is scheduled to end before the indicators have been validated, the Commission needs to consider extending the life of the project.

Third, as was evident during the discussion, there is a need for common terminology so that the users of such data understand what the results do and don't mean. This is particularly the case with respect to distinguishing between the terms "risk indicators" and "risk assessment."

Next steps

Delegates also suggested areas which might be ripe for further exploration within the RRSG.

Delegates noted that as currently most OECD countries conduct surveys to determine residue levels in food, as well as dietary consumption patterns, there may be value in exchanging information or experiences, and considering the possible value of harmonising such surveys.

Consideration could also be given to bringing experts in member countries who work on indicators together to explore, at the technical (and user) level, how data could be exchanged, and whether existing formats pose any problems to such an exchange.

Finally, many Delegates indicated their interest in continuing to monitor the progress of work on HAIR, and to further explore how it could be used by non-EU countries. The EC noted that there will be a trial period for HAIR, and OECD countries were invited to provide comments. With respect to use outside of the EU, it was noted that as HAIR is based on modular-based indicators, it is possible to tailor such modules to fit particular needs (e.g., countries can use the indicators and employ data unique to them such as geography or climate).

Conclusion

The Chairman concluded the discussions by thanking all of the speakers for their informative presentations, and the HAIR group for organising the discussion. He also said that the outcome of the seminar would be discussed at the next meeting of the RRSG, scheduled for March, 2007 in Brno, Czech Republic.

ANNEX 1: AGENDA OF THE SEMINAR

TIME	ITEM	DESCRIPTION
10:30	1	**INTRODUCTION**
	A	Introduction to the background of the joint seminar and of the project (10 minutes) *Wolfgang Zornbach*
	B	Introduction to Sixth Framework Programme (FP6). (10 minutes) *Danièle Tissot(DG Research, European Commission)*
	C	Introduction to HAIR (10 minutes) *Robert Luttik (RIVM, The Netherlands)*
11.00	2	**DATA REQUIREMENTS FOR APPLICATION**
	A	GIS DATA (10 minutes) *Declan Mulligan (JRC, Italy)*
	B	COMPOUNDED RELATED DATA (toxicity and fate) (10 minutes) *Peter van Vlaardingen (RIVM, The Netherlands)*
	C	USE AND USAGE DATA (20 minutes) *Miles Thomas (CSL, UK)*
	D	DISCUSSION (20 minutes)
12.00	3	**INDICATORS**
	A	AQUATIC INDICATORS (15 minutes) *Jörn Strassemeyer (BBA, Germany)*
	B	TERRESTRIAL INDICATORS (15 minutes) *Villie Flari (CSL, UK)*
12:30		LUNCH
14:00	3	**INDICATORS** *(…cont'd)*
	C	GROUNDWATER INDICATORS (15 minutes). *Ton van der Linden (RIVM, The Netherlands)*
	D	CONSUMER INDICATORS (15 minutes) *Marco Trevisan (Università Cattolica del Sacro Cuore, Italy)*

	E	WORKER INDICATORS 15 minutes) *Floortje Garreyn (University of Gent, Belgium)*
	F	Discussion (15 minutes)
15:00	4	**AGGREGATIONS** (15 minutes) *Juan Piñeros (University of Gent, Belgium)*
15:15	5	**VERIFICATION** (20 minutes) *Christian Damgaard (NERI, Denmark)*
15:35	6	**CONCLUDING PRESENTATION ON PROGRAM** (40 minutes) *Arjan de Jong (Alterra, The Netherlands)*
16.15	7	**DISCUSSION and CONCLUSIONS** (35 minutes)
16:50		END OF SEMINAR

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ANNEX 3: SEMINAR PRESENTATIONS AND PAPERS

- Introduction to HAIR *(Robert Luttik, RIVM, the Netherlands)*
- GIS Related Database *(Declan Mulligan, JRC, Italy)*
- Compound Properties Database *(Peter van Vlaardingen, RIVM, The Netherlands)*
- Pesticide Use Database *(Miles Thomas, CSL, UK)*
- Aquatic Risk Indicators *(Jörn Strassemeyer, BBA, Germany)*
- Terrestrial Risk Indicators *(Villie Flari, CSL, UK)*
- Groundwater Indicators *(Ton van der Linden (RIVM, The Netherlands)*
- Consumer Indicators *(Marco Trevisan, Università Cattolica del Sacro Cuore, Italy)*
- Occupational Indicators for Pesticide Risk *(Floortje Garreyn, University of Gent, Belgium)*
- Validation of Indicators *(Peter B Sorensen, NERI, Denmark)*
- Risk Aggregration (*Juan Piñeros, University of Gent, Belgium*)

Robert Luttik | 13 November 2006

HArmonised environmental Indicators for pesticide Risk (HAIR)

COMMUNITY RESEARCH

HAIR is supported by European Commission's 6th Framework Programme, contract no. SSPE-CT-2003-501997. This presentation does not represent the views of the Commission or its services

HAIR

- HAIR is a specific targeted research project (STREP)
- € 2.700.000 (€ 1.700.000 of the EU)
- 17 contractors
- 9 European countries: Belgium, Denmark, Germany, Hungary, Italy, Norway, Switzerland, The Netherlands, United Kingdom.
- Universities and governmental research institutes
- Project has started on the first of January of 2004 and the duration is 3 years and 3 months

HAIR Workpackages

• Co-ordination/management	The Netherlands
• Workshop	The Netherlands
• GIS related data base	JRC Italy
• Compound related database	The Netherlands
• Usage/sales database	United Kingdom
• Terrestrial indicators	United Kingdom
• Aquatic indicators	Germany
• Groundwater indicators	The Netherlands
• Indicators for consumers	Italy
• Indicators for workers	Belgium
• Aggregation of indicators	Belgium
• Software	The Netherlands
• Verification of indicators	Denmark together with Switzerland

State of the art in in HAIR

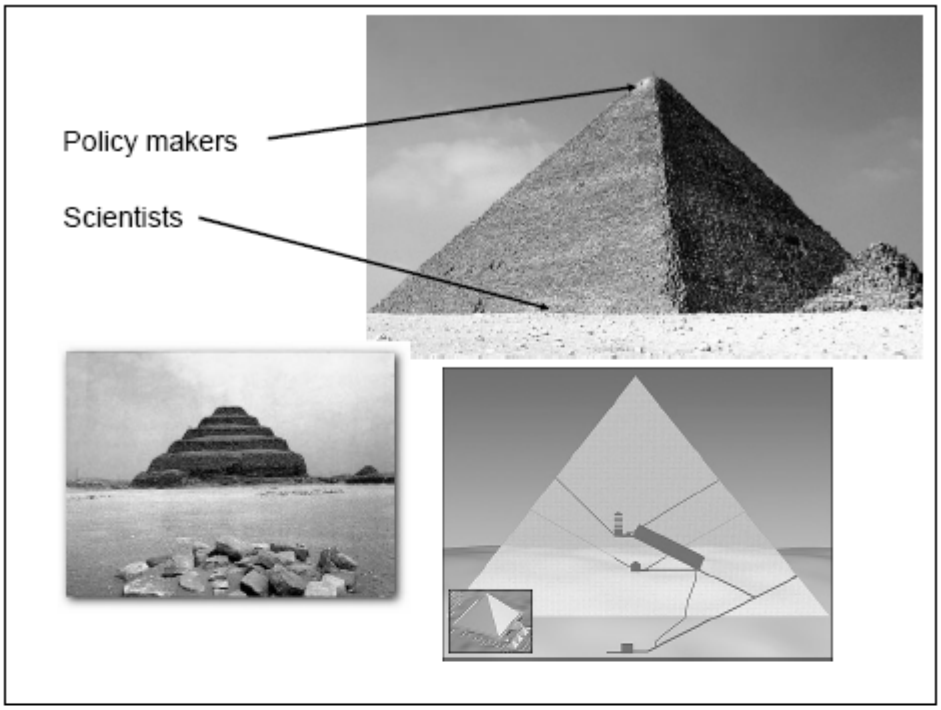
• January 2004	Start of project	ready
• May 2004	Workshop	ready
• April 2005	Indicators for acute situation	ready
• November 2005	First version of software package	ready
• April 2006	Indicators for chronic situation	ready
• December 2006	Final version of software package	
• March 2007	Final report, manual and CD with software	

Final products will be made available as:

- Files at the HAIR-site: http://www.rivm.nl/rvs/overige/risbeoor/Modellen/HAIR.jsp
- CD with reports and program

Follow up ?

- **Sustainable Use of Pesticides and the HAIR indicators?**
- **OECD and HAIR indicators?**
- **Maintenance of HAIR indicators**
- **Uniformity of input data:**
  - Use and Usage data (EUROSTAT?)
  - Compound related data (EFSA? Footprint?)
- **Further development**
  - OECD (??)
  - EU (??)
  - Member state level (??)



Program of today

The presentations of today will deal with:

- The information needed for running the indicators
- The indicators
- Aggregation and
- Verification

We will show the computer model

We hope to have discussions over:

- The HAIR indicators and the model, and
- The follow up

Program of today

This EU-OECD joint seminar is scheduled to present the results of the EU HAIR-project, discuss related issues for further developments and consider the ways of broadening their use to the OECD member countries.

One of the questions that has been encountered is to what degree of depth it is desirable to achieve in developing indicators.

If one would adopt the German approach for surface water, for example, a great deal of information is required, which is, at present, available only in Germany.

There are similar kinds of indicators developed in Denmark also (e.g. load index indicator and frequency of application indicator), which will probably be adopted by the FAO.

These indicators can be run with relatively little information (i.e. toxicity, application rate and sales data (kg sold)).

Program of today

The HAIR project has sought the middle-of-the-road possibility, which could be run in most European countries.

All indicators that will been shown are risk quotient indicators (PEC/TOX quotients).

There is another type of indicators which are developed based on field research.

The Canadian indicator of Pierre Mineau is falling within this category which relates the chance of incidents with the use of pesticides for birds.

Another example is the indicator developed by Mathias Liess, which relates the acute use of pesticides to effects occurring in streaming rivers.

Work package 3
GIS Related Database

Osmate – Spring

Declan Mulligan - JRC
Bonn 13th November 2006

Objectives and Description

Objectives:

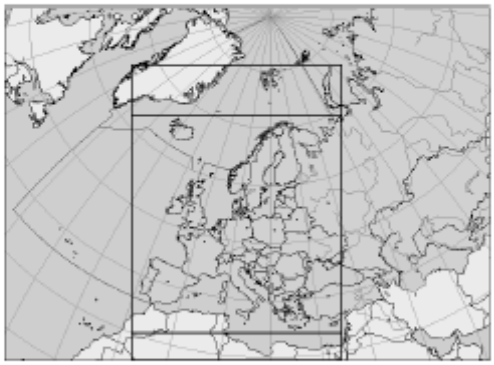
Establishment of consistent databases on land use and environmental and climatic conditions, which are necessary for the calculation of Predicted Environmental Concentration throughout member states to allow seamless transfer of data into other packages used in modelling and indicator development

Description of work:

- Establishment of the availability and current format of data relevant to the HAIR project
- Establish format and requirements of data for use by other work packages
- Design database to hold available data in appropriate format for use by other modules
- Deliver example database for the regional, national and international scale

Database format

- Projection: Lambert-Azimuthal Equal-Area projection (ETRS_1989_LAEA)
  Equal area grid suitable for generalising data, statistical mapping and analytical work where an equal area of cells is important.

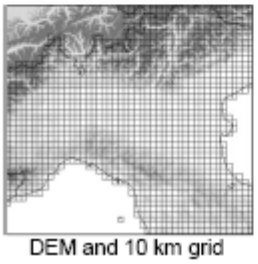


- INSPIRE framework for spatial data reporting: COM(2004) 516, 23.7.2004
  Extent EU25 + EFTA +CC2

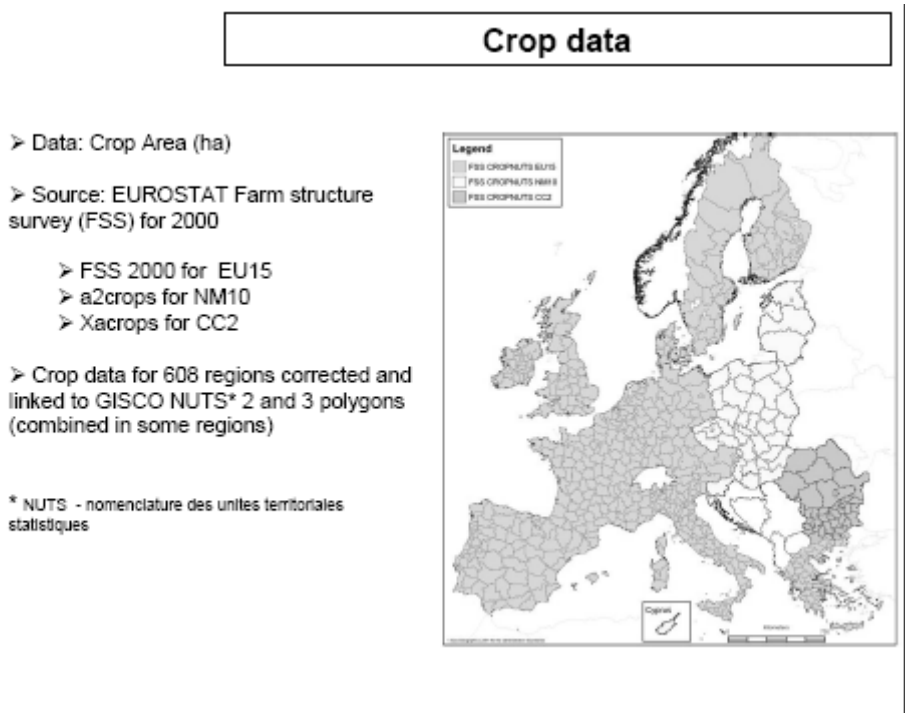
- Data availability and format
  - GIS Shapefiles
  - Tabular: dbf files
  - Available on ftp site

Base Grids

- Two grids created to contain data required by the other modules
- 10 km x 10 km Grid HAIRNET10K (450 rows x 450 columns)
- 25 km x 25 km Grid HAIRNET25K (180 rows x 180 columns)
- Each cell given a unique identifier



DEM and 10 km grid

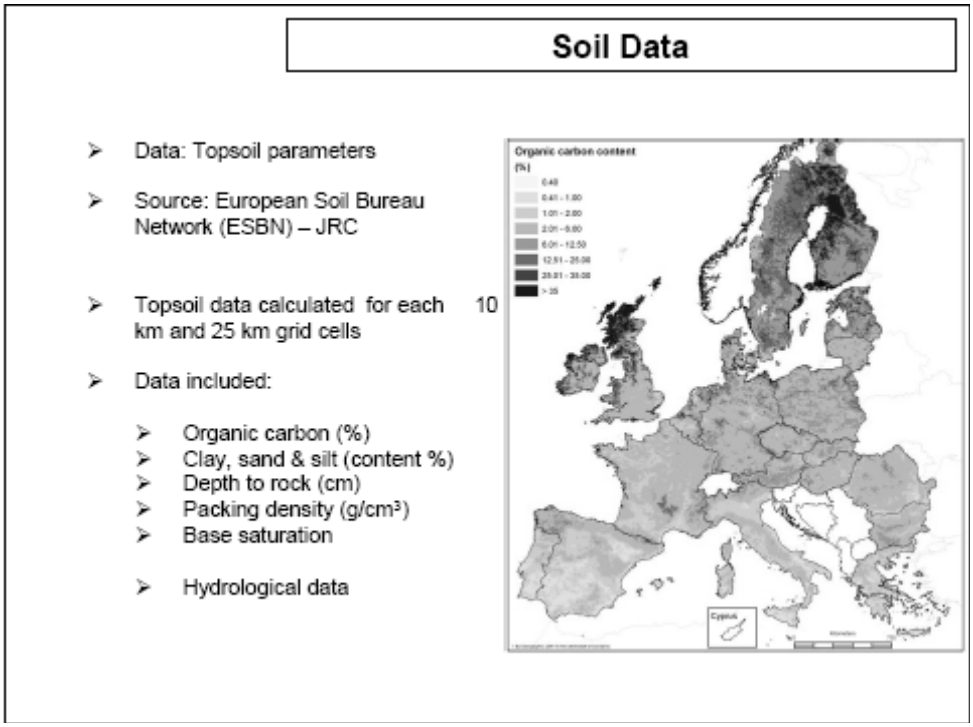


Agricultural data of crop area and yield has been derived form the EUROSTAT – New Cronos database.

The table 'a2efarm' (Structure of agricultural holdings by region) contains the main characteristics of the Community surveys on the structure of agricultural holdings from 1990 onwards. As from 1990, EUROSTAT receives data on individual agricultural holdings collected during Farm Structure Surveys conducted approximately every 10 years in all the Member States of the European Union. Smaller sample surveys take place three times between the full FSS.

Crop production (Table: a2crops). This data corresponds to "harvested" production, including losses and waste on the farm, quantities consumed directly on the farm and quantities marketed

The statistical tables have been linked to a coverage of NUTS regions.



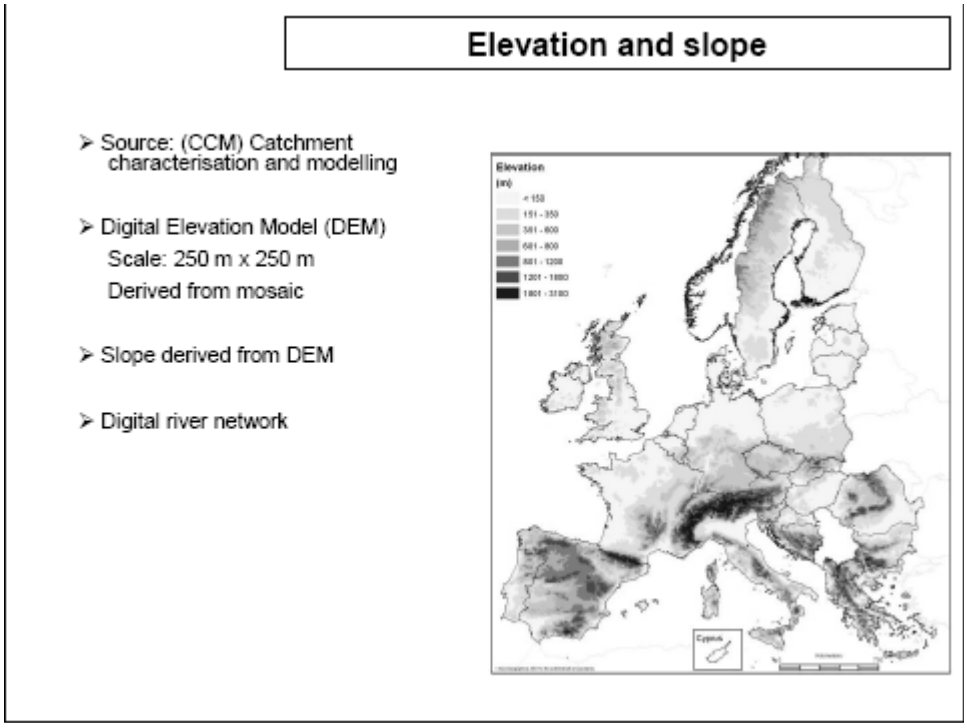
Pan European soil data were available from the Soil and Waste Unit of European Commission's JRC through the activities of the European Soil Bureau Network (ESB). The European Soil Database (ESBD) v1.0 described by (Montanarella and Jones, 1999): incorporates the following datasets

Soil Geographical Database of Europe (SGBDB) v 3.2.8.0.

Soil Profile Analytical Database of Europe (SPADE) v 2.0.

Hydraulic Properties of European Soils (HYPRES) database linked to the 1:1,000,000 (1:1 M) SGDBE v 1.0.

Pedo-transfer Rules (PTR) database derived from an expert system for the estimation of several additional parameters needed for environmental interpretations of the soil map.



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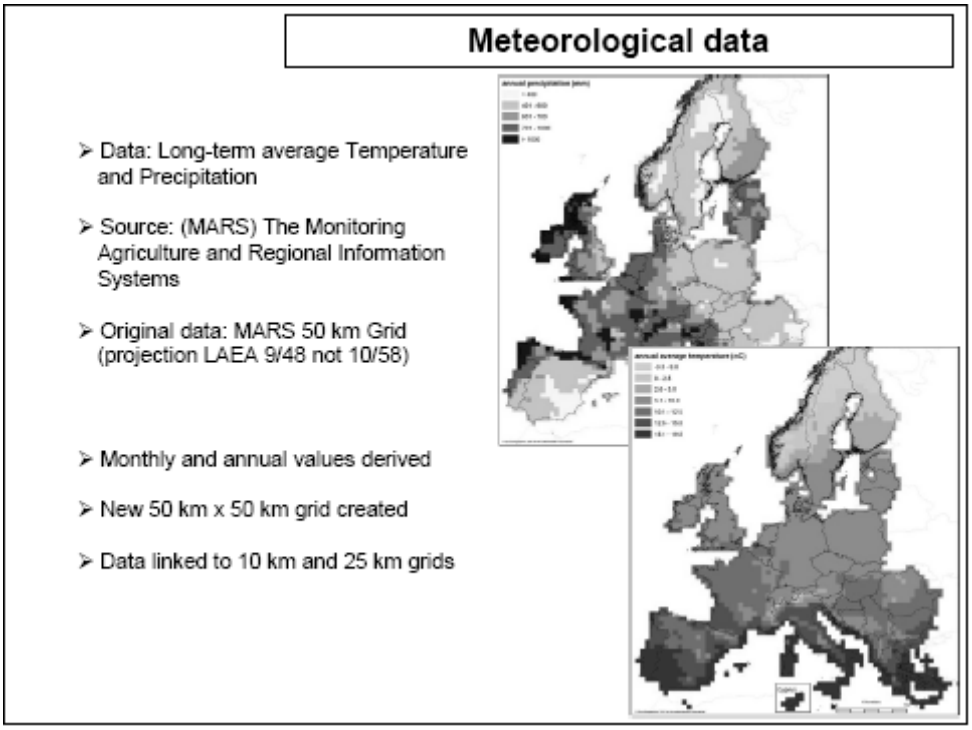


The Monitoring Agriculture and Regional Information Systems (MARS) Unit of the JRC (possess an archive of daily surface meteorological measurements (shown in table 3) from more than 1500 weather stations across Europe. These meteorological parameters have been spatially interpolated onto a 50 km x 50 km grid by selecting the best combination of surrounding meteorological stations for each grid.

Conclusion

This work package provided:

- An assessment of data availability across member states and suitability for incorporation into the HAIR system
- An assessment of system requirements as defined by other work packages
- Specification for the database
- A harmonised database populated with pan-European data available to all HAIR project partners

Thank You

Declan Mulligan - JRC

Bonn 13th November 2006

Peter van Vlaardingen, Ton van der Linden, Marian Post,
Arjen Wintersen, Huub van den Broek

HAIR - Work Package 4
Compound properties database

Joint OECD/HAIR Seminar
Bonn | November 13, 2006

WP 4 Database on compound related properties

HAIR software program: various indicators,
surface water, consumers, earthworms…

run calculations based on:

- GIS data (WP3)
- data on compound properties (**WP4**)
- usage and/or sales data (WP5)

2

Compound properties database - type of data (1)

Parameter requirements (compound properties) of the various indicators have been established

1. Identification

- Active substance name: ISO (UK)
- Chemical Abstract Service registry nr. (CAS nr.)
- Unique HAIR number:
  - harmonised with WP5 (usage and sales data)
  - facilitating seemless transfer of data between various WPs
- Chemical use (insecticide, herbicide, plant growth regulator, etc.)
- Chemical class (pyrethroid, triazole, organophosphorous, etc.)
- Mode of action (systemic, contact, inhibition of choline esterase, etc.)

e-Pesticide manual (Tomlin, 2002)

3

Compound properties database - type of data (2)

2. Physico-chemical

- Molecular weight
- Vapour pressure
- Water solubility
- Henry's law constant
- Log K_{ow}
- pK_a

3. Environmental fate

- DT50 soil and DT90 soil (aerobic)
- DT50 hydrolysis
- DT50 photolysis water

4

Compound properties database - type of data (3)

3. Environmental fate
- DT50 water, DT50 sediment, DT50 system
- DT50 plant leaf
- K_{oc}, K_{om}

4. Ecotoxicity
- LC50 and NOEC for algae, *Daphnia*, fish, aquatic higher plant, LC50 and NOEC for earthworms
- LD50 bee_{oral}, LD50 $bee_{contact}$
- LD50 duck, quail; LC50 bird (various species); NOEL bird
- LR50 non target arthropods
- Soil microbial parameters (e.g. biomass, respiration, N_2 fixation, etc.)

5

Compound properties database - type of data (4)

5. Human & mammalian - thresholds and toxicity
- ADI, ARfD, MRL
- LC50, LD50 rat, LD50 other mammal (various species)
- NOEL (various mammalian species)

6. Formulation related properties (member state specific)
- Formulation name
- Name(s) of actives in formulation (+id.)
- % of active(s) in formulation (granule)
- Use type (spray, WP, granule, etc.)
- Weight of granule
- Density of formulation

6

Compound properties database - type of data (4)

7. Monitoring data

- Monitoring: highest residue (HR) in composite sample of edible portion
- Monitoring: median residue (MR) in crop (processed)
- Transformation factor (TF)
- Field data on exposure (worker and bystander)

7

Populating database with data (1)

- Several data collections were obtained:
  - Biologische Bundesanstalt (BBA, Germany)
  - SEEM (EU project)
  - Central Science Laboratory (CSL, United Kingdom)
  - University of Ghent (UGhent, Belgium)
  - National Institute for Public Health and the Environment (RIVM, Netherlands, 'example dataset')

Some detail on datasets:

- BBA, SEEM, RIVM: physico-chemical, fate and ecotoxicity data

  - BBA, SEEM: mainly data from EU-registration process
  - RIVM: data from Dutch registration process

8

Populating database with data (2)

Some detail on datasets

- CSL: ADI, ARfD, MRL, NOEL, LD50 mammal (rat)
  - Data mainly from EU-registration process
- UGhent: AOEL
- Number of compounds represented: BBA: 242 actives, SEEM: 200, RIVM: 243, CSL: 521, UGhent: 482

- Problems:

1. Overlap in datasets, but: sources of data unknown
2. Data missing in all datasets

9

Populating database with data (3)

Problem 1 (overlap) – solution:

Tracking down or establishing *THE* value for each parameter is outside scope of HAIR:
very laborious (but very worthwile; e.g. FOOTPRINT-project).

- Use all datasets as received, with selection possibility

Problem 2 (missing data) – solution:

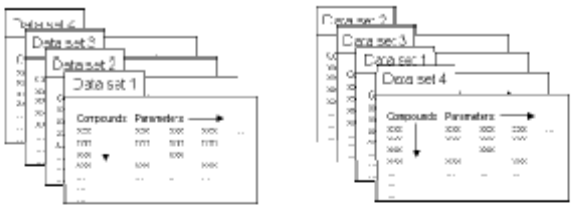
Some parameters were needed, but data collections simply did not (yet) exist.

- Missing value routines
- End user can enter his/her own dataset

10

Compound property database – basic outline

Structure of the database:



- "Dataset" = one vertical compound column and several data columns (2 dimensional table)
- Various 2D-datasets carry all information needed
- End user will be able to change *order* of datasets

11

Compound property database – detail

- Within HAIR all datasets contain *one value per parameter*
  e.g. atrazin – water solubility = 33 $mg.L^{-1}$

- In case of multiple values in underlying databases:
  - select reliable values
  - select values at relevant pH, temperature
  - transform to standard temperature (e.g. 20° C)
  - arithmetic mean for S_w, P_v, log K_{ow}, K_{om}
  - geometric mean for DT50

- Amendment to "keep close to registration process"
  Geometric mean of ecotox endpoints per species,
  e.g. EC50 *Daphnia magna*

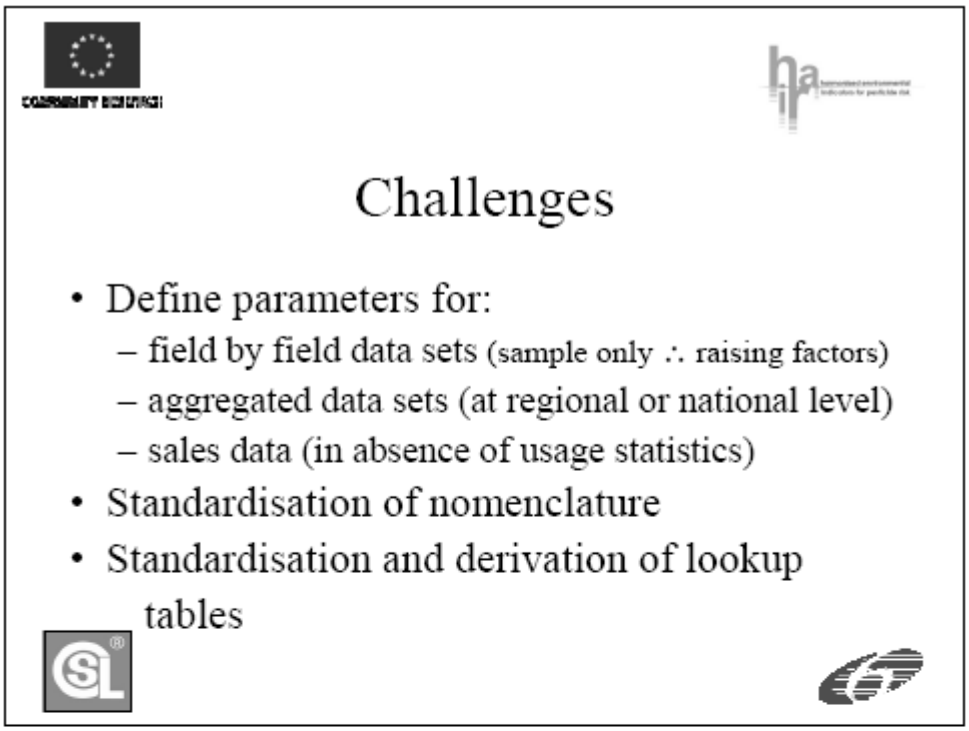
12

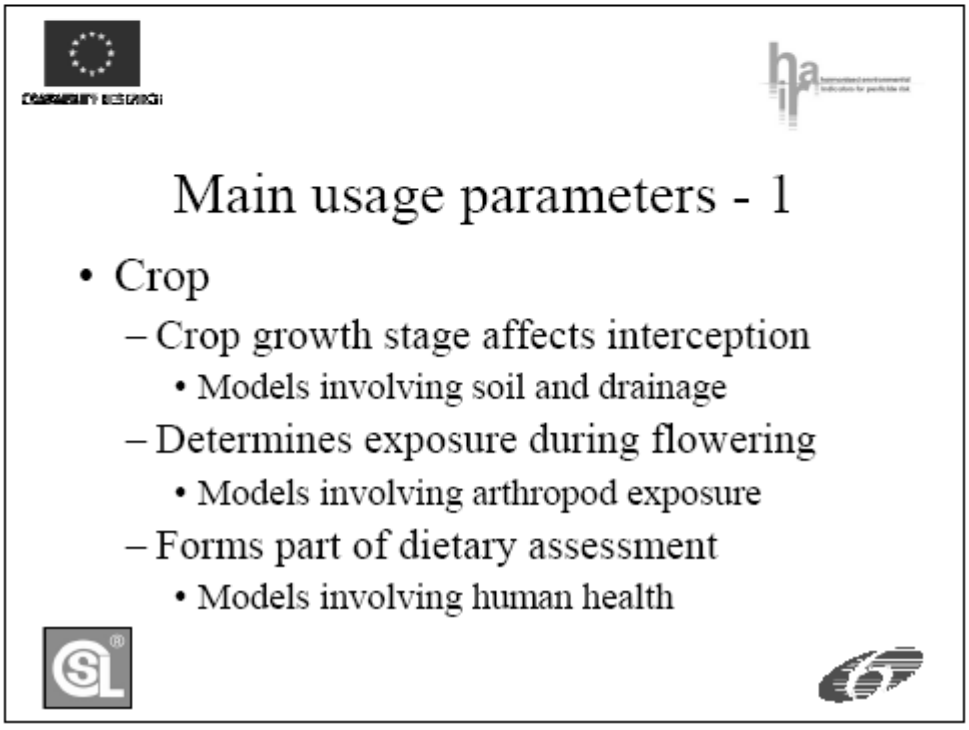
Work Package 5
Pesticide Use Database

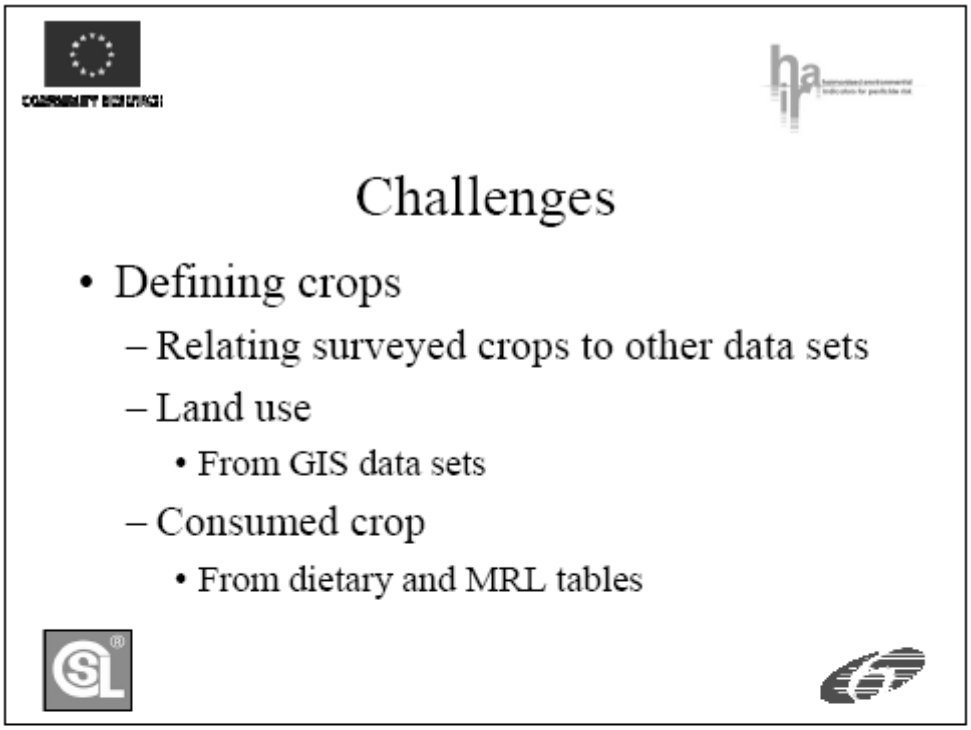
Miles R Thomas
CSL
UK

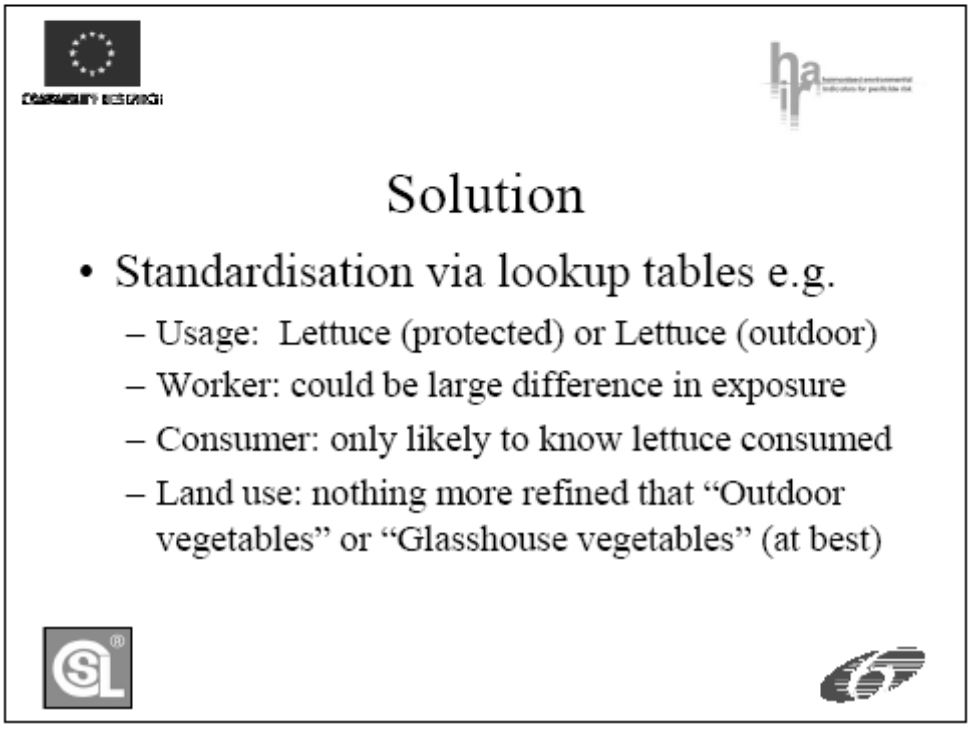
Challenges

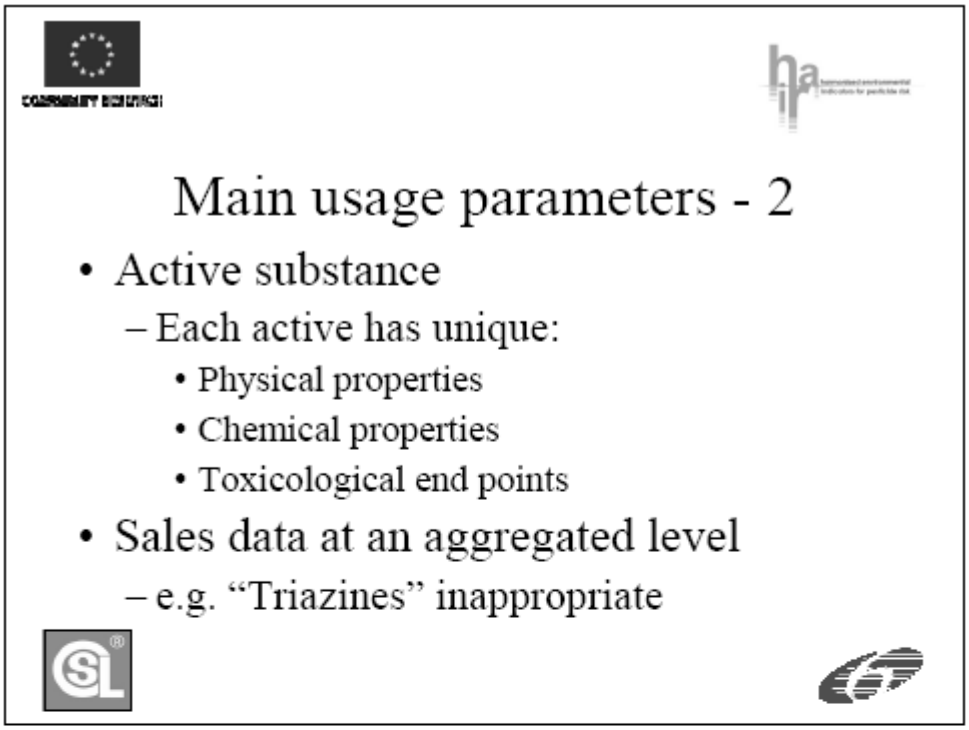
- Most indicators require detailed parameters
- Most countries don't have such usage data
- Define what parameters required by each indicator are actually deliverable
- Deliver a data set to meet these requirements for indicator testing

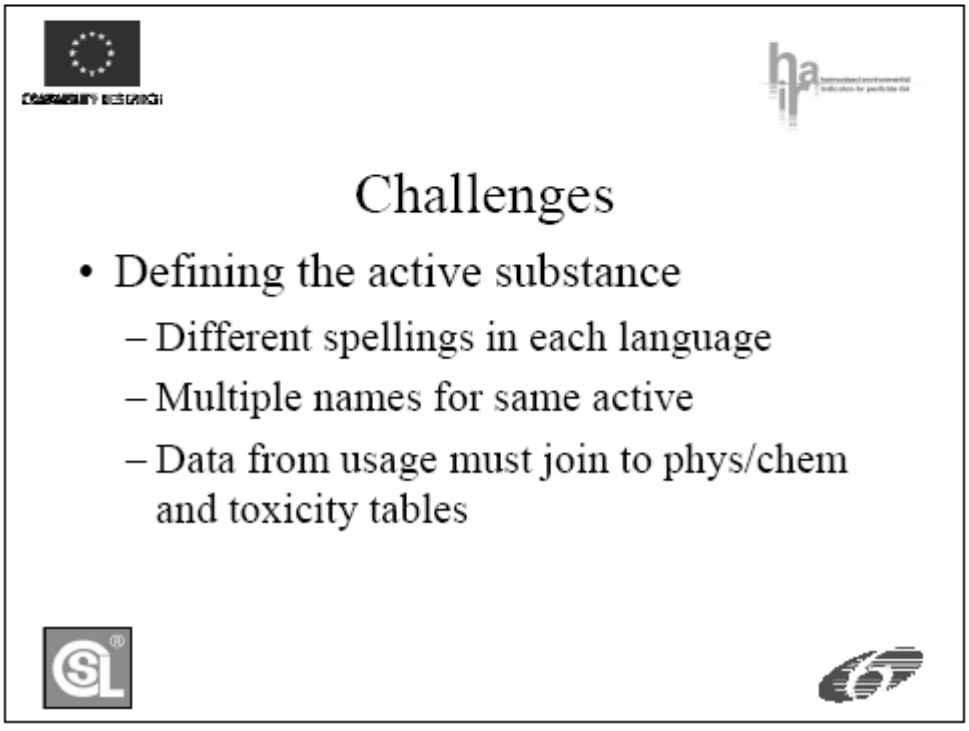

Challenges
• Define parameters for:
– field by field data sets (sample only ∴ raising factors)
– aggregated data sets (at regional or national level)
– sales data (in absence of usage statistics)
• Standardisation of nomenclature
• Standardisation and derivation of lookup tables

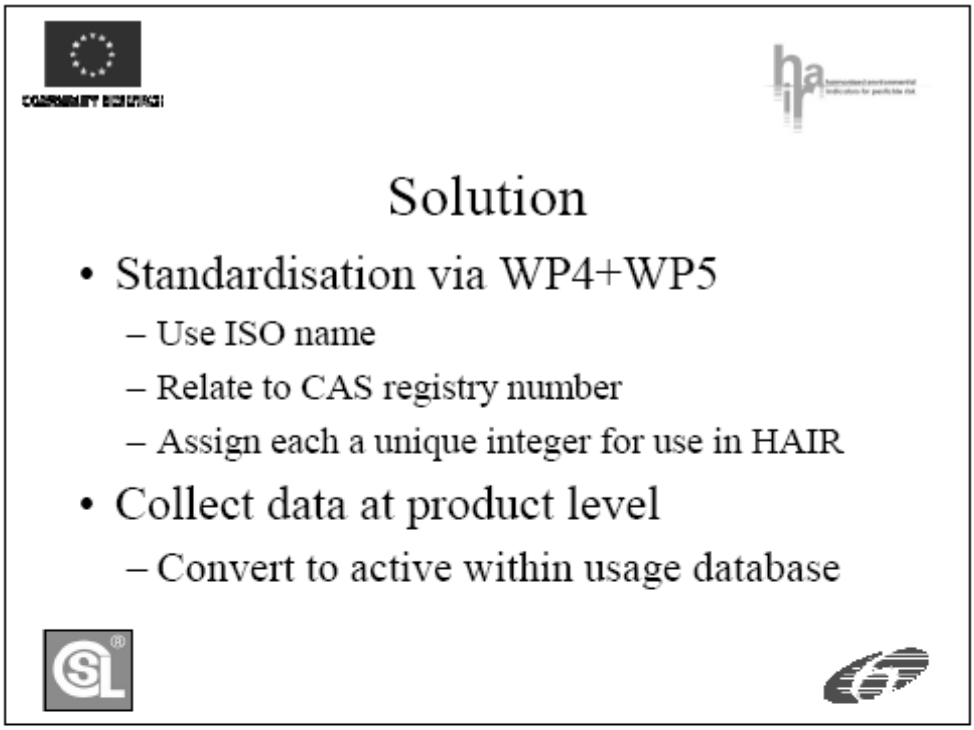

Main usage parameters - 1
• Crop
– Crop growth stage affects interception
• Models involving soil and drainage
– Determines exposure during flowering
• Models involving arthropod exposure
– Forms part of dietary assessment
• Models involving human health

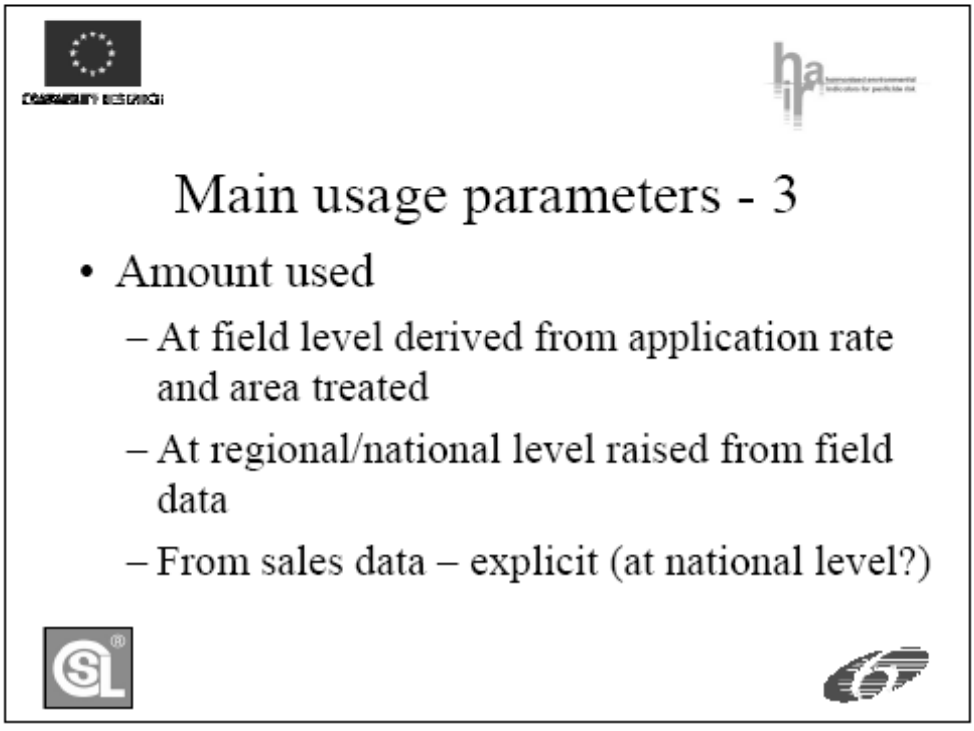

Challenges
• Defining crops
– Relating surveyed crops to other data sets
– Land use
• From GIS data sets
– Consumed crop
• From dietary and MRL tables

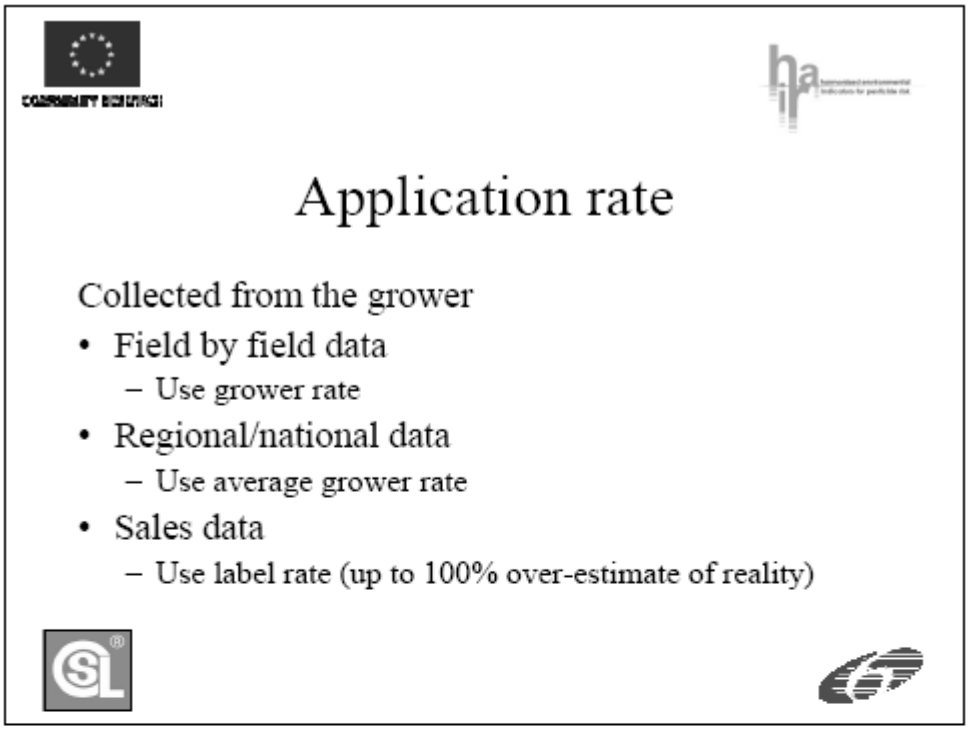

Solution
• Standardisation via lookup tables e.g.
– Usage: Lettuce (protected) or Lettuce (outdoor)
– Worker: could be large difference in exposure
– Consumer: only likely to know lettuce consumed
– Land use: nothing more refined that "Outdoor vegetables" or "Glasshouse vegetables" (at best)

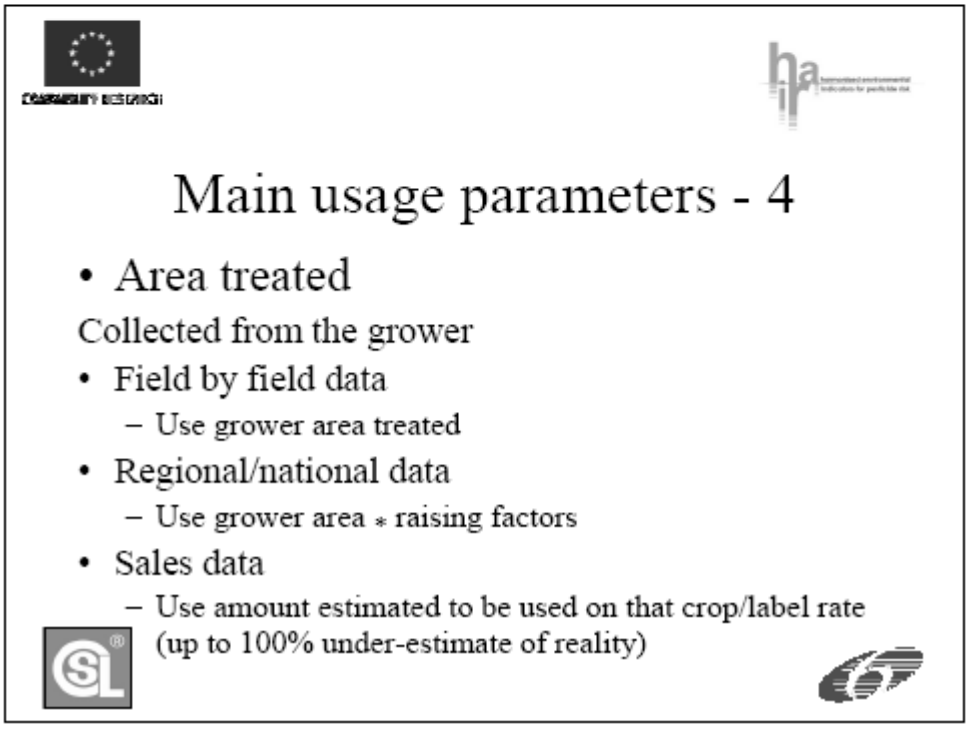

Main usage parameters - 2
• Active substance
– Each active has unique:
• Physical properties
• Chemical properties
• Toxicological end points
• Sales data at an aggregated level
– e.g. “Triazines” inappropriate

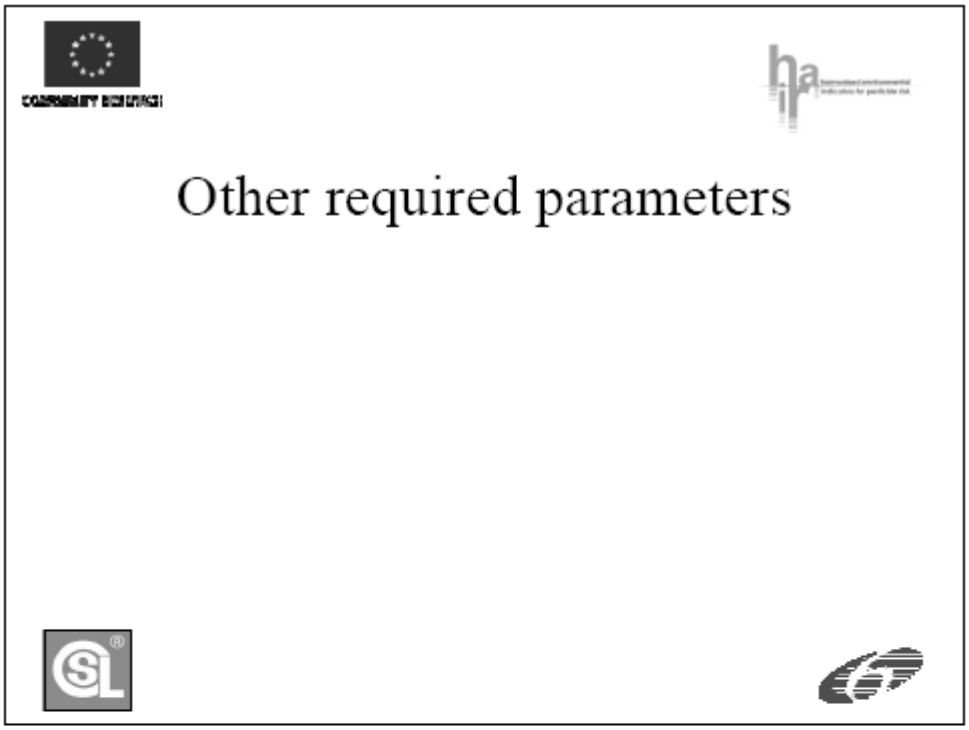

Challenges
• Defining the active substance
– Different spellings in each language
– Multiple names for same active
– Data from usage must join to phys/chem and toxicity tables

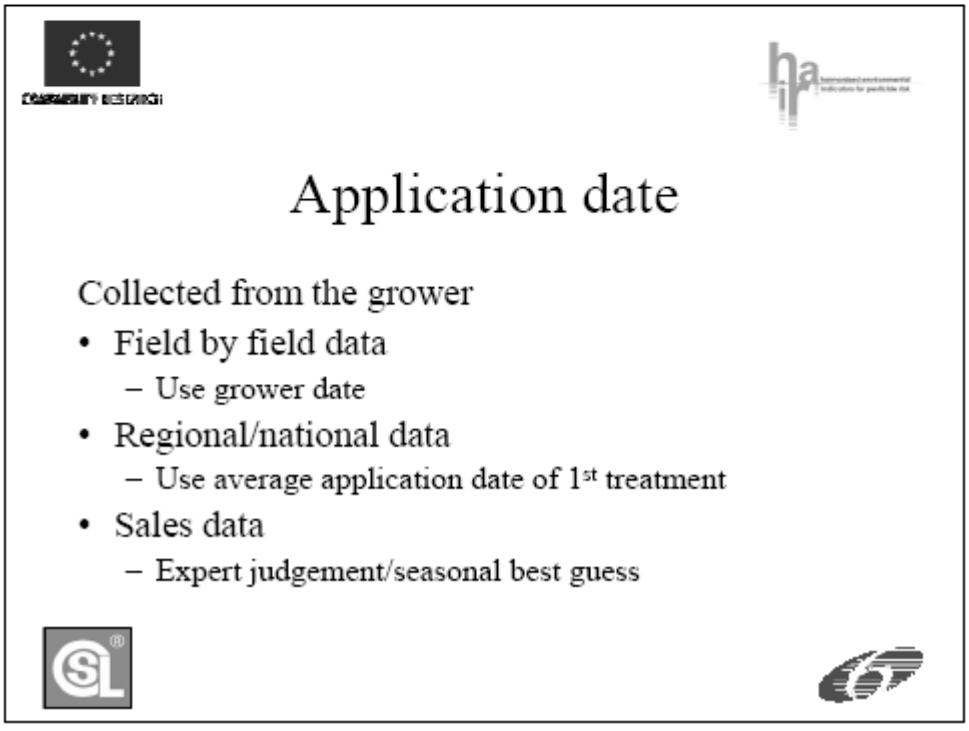

Solution
• Standardisation via WP4+WP5
– Use ISO name
– Relate to CAS registry number
– Assign each a unique integer for use in HAIR
• Collect data at product level
– Convert to active within usage database

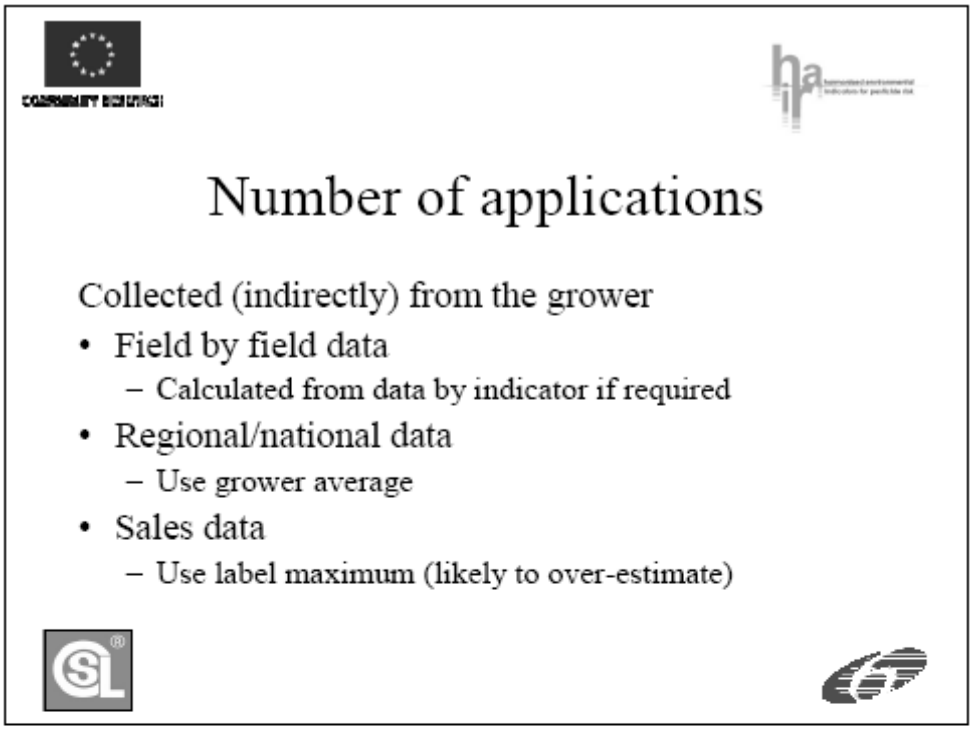

Main usage parameters - 3
• Amount used
– At field level derived from application rate and area treated
– At regional/national level raised from field data
– From sales data – explicit (at national level?)

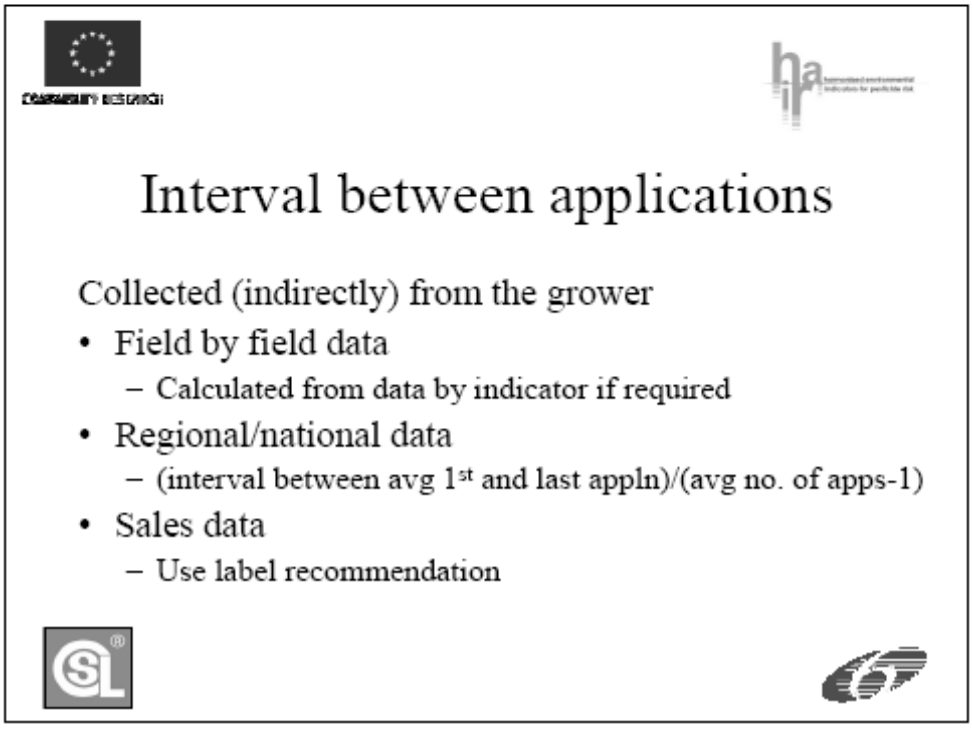

Application rate
Collected from the grower
• Field by field data
– Use grower rate
• Regional/national data
– Use average grower rate
• Sales data
– Use label rate (up to 100% over-estimate of reality)


Main usage parameters - 4
• Area treated
Collected from the grower
• Field by field data
– Use grower area treated
• Regional/national data
– Use grower area * raising factors
• Sales data
– Use amount estimated to be used on that crop/label rate
(up to 100% under-estimate of reality)


Other required parameters


Application date
Collected from the grower
• Field by field data
– Use grower date
• Regional/national data
– Use average application date of 1st treatment
• Sales data
– Expert judgement/seasonal best guess


Number of applications
Collected (indirectly) from the grower
• Field by field data
– Calculated from data by indicator if required
• Regional/national data
– Use grower average
• Sales data
– Use label maximum (likely to over-estimate)


Interval between applications
Collected (indirectly) from the grower
• Field by field data
– Calculated from data by indicator if required
• Regional/national data
– (interval between avg 1st and last appln)/(avg no. of apps-1)
• Sales data
– Use label recommendation

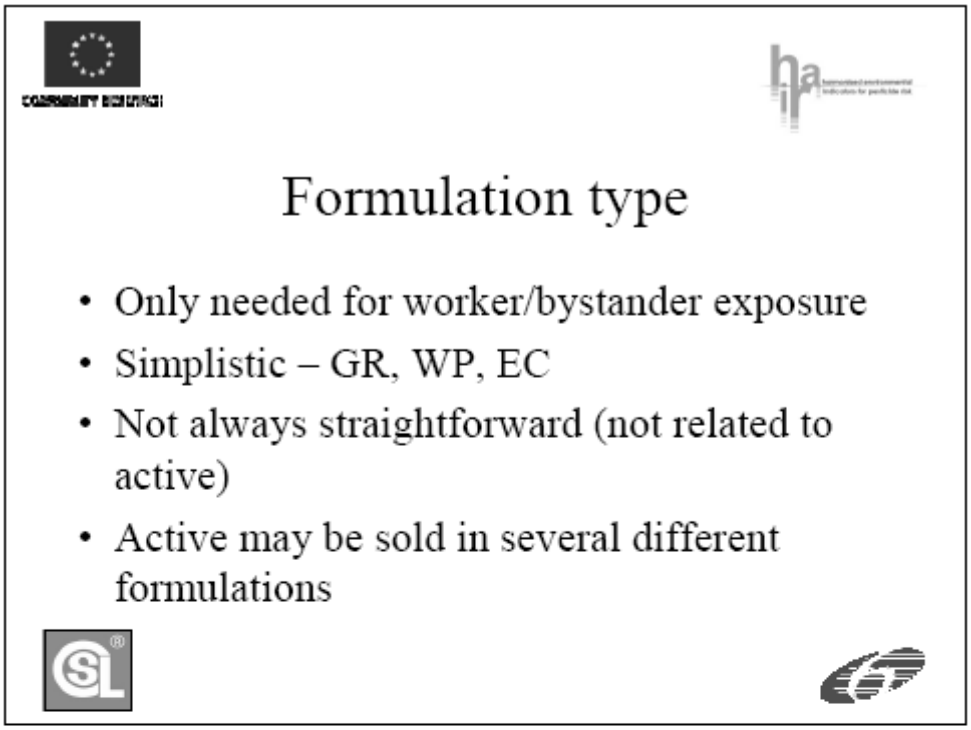
Method of application

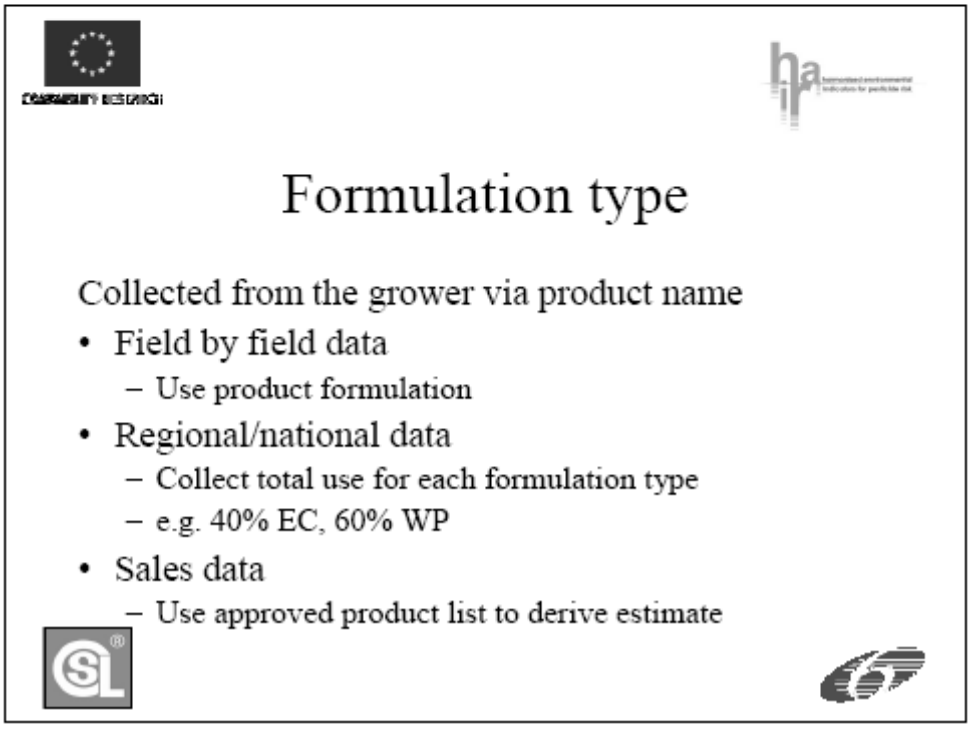
- Only granules, spray or seed treatment for some WPs
- Broadcast or incorporated (wildlife impact)
- Air blast, ground spray, handheld etc. for worker (& aquatic – drift/buffer zones etc.)

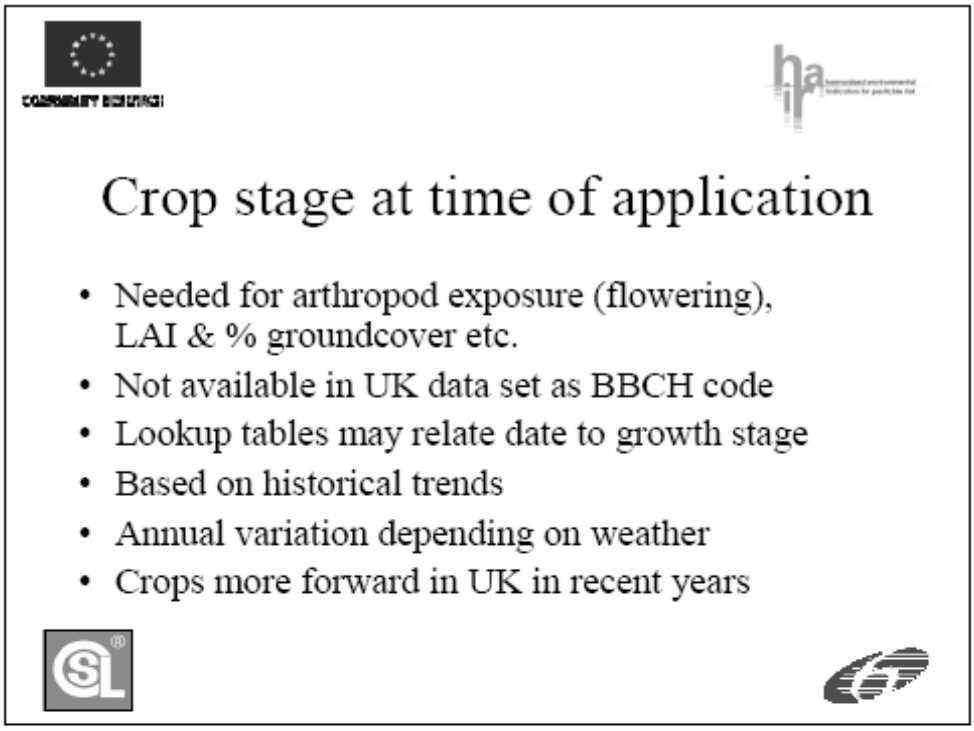
Method of application

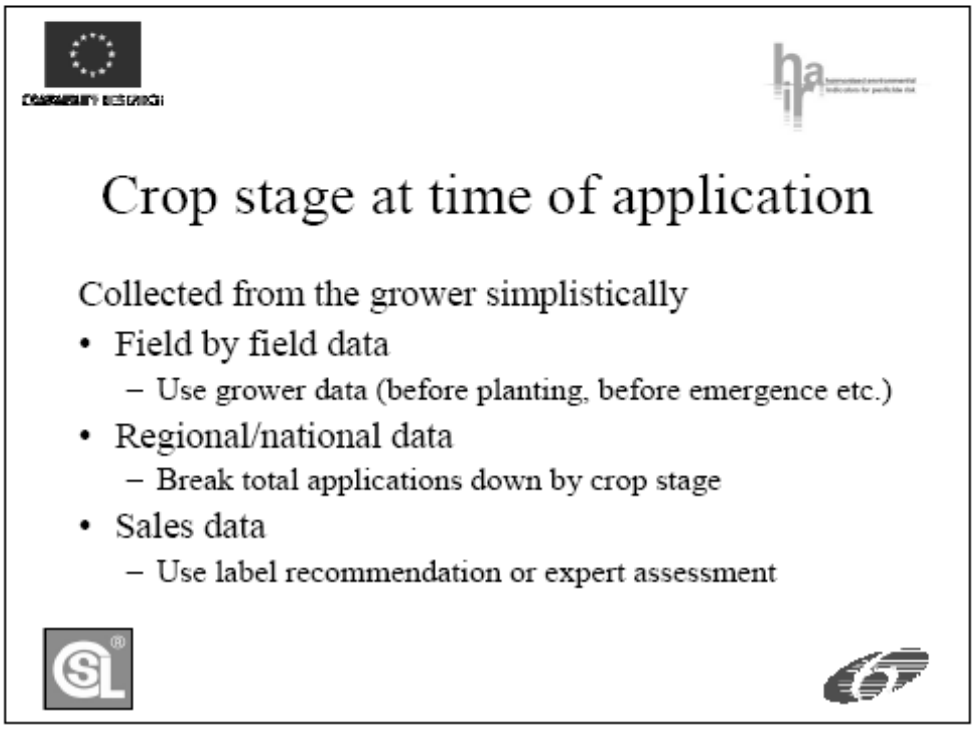
Collected from the grower

- Field by field data
  - Use grower method
- Regional/national data
  - Collect total use for each method
  - e.g. 40% incorporated, 60% broadcast
- Sales data
  - Use label recommendation or expert assessment (can we relate active to product where > 1 method)


Formulation type
• Only needed for worker/bystander exposure
• Simplistic – GR, WP, EC
• Not always straightforward (not related to active)
• Active may be sold in several different formulations


Formulation type
Collected from the grower via product name
• Field by field data
– Use product formulation
• Regional/national data
– Collect total use for each formulation type
– e.g. 40% EC, 60% WP
• Sales data
– Use approved product list to derive estimate


Crop stage at time of application
• Needed for arthropod exposure (flowering), LAI & % groundcover etc.
• Not available in UK data set as BBCH code
• Lookup tables may relate date to growth stage
• Based on historical trends
• Annual variation depending on weather
• Crops more forward in UK in recent years


Crop stage at time of application
Collected from the grower simplistically
• Field by field data
– Use grower data (before planting, before emergence etc.)
• Regional/national data
– Break total applications down by crop stage
• Sales data
– Use label recommendation or expert assessment

Also required

- Pre-harvest interval & date of harvest
  - Consumer exposure parameter
- Application volume
  - Worker exposure & terrestrial indicator parameter
- Work rate & duration of spraying
  - Worker & bystander exposure parameters
- Use of PPE
  - Worker exposure parameter

Conclusions

- Usage parameters required will be supplied from UK data set
- Other countries may not have data at that level of detail
- PHARE training programme incorporates these requirements for accession countries
- Related parameters may not be readily available
- Availability of data should be the starting point for indicator development

Aquatic risk indicator :

A comparison of input requirements and interpretation possibilities for three cases of data availability

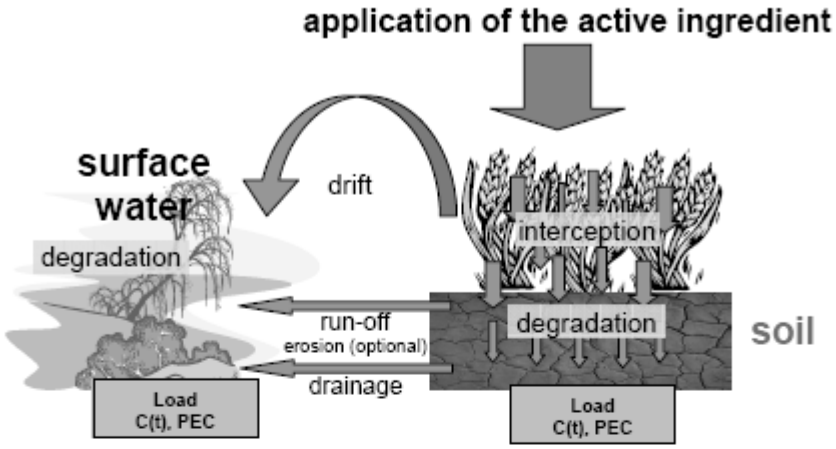
Jörn Strassemeyer, Volkmar Gutsche

Contents

Introduction of the indicator model

Definition of three cases of data availability
necessary input parameters
first simulation results

Modeled pathways



Modeled pathways

The following algorithms are used to predict the exposure

- Spray drift (Ganzelmeier Tables + FOCUS functions)
- Run-Off (Model developed by Lutz 1984, SYNOPS, REXTOX)
- Drainage (meta-model based on MACRO)
- Erosion (USLE based model, comparable to FOCUS)

Exposure-Toxicity-Ratio: *ETR*

The **risk potential** will be expressed as a ratio of the **exposure** (Predicted Environmental Concentration:*PEC*) and the **toxicity of the active substance** (*LC50*).

acute risk potential

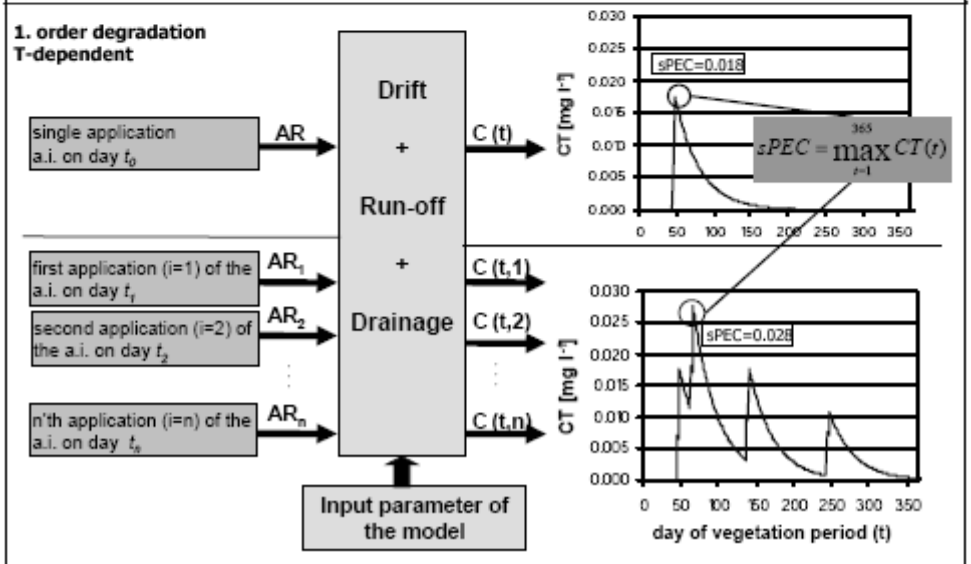
$$ETR_{acute} = \frac{sPEC}{LC50_{species}}$$

chronic risk potential

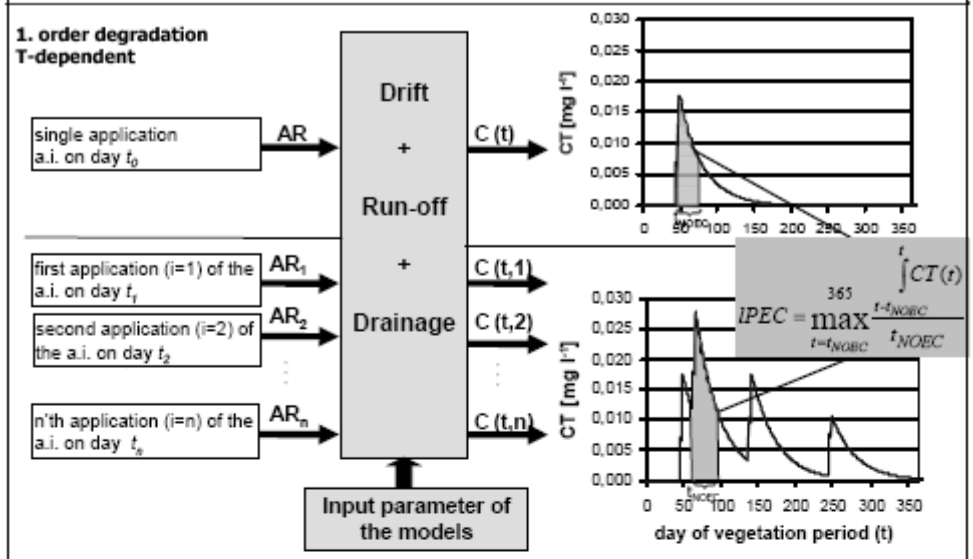
$$ETR_{chronic} = \frac{lPEC}{NOEC_{species}}$$

$ETR_{species}$	Exposure-Toxicity-Ratio
sPEC	short-term exposure in the surface water
lPEC	long-term exposure in the surface water
$LC50_{species}$	Lethal concentration
$NOEC_{species}$	No effect concentration

Calculation of *sPEC*: acute risk

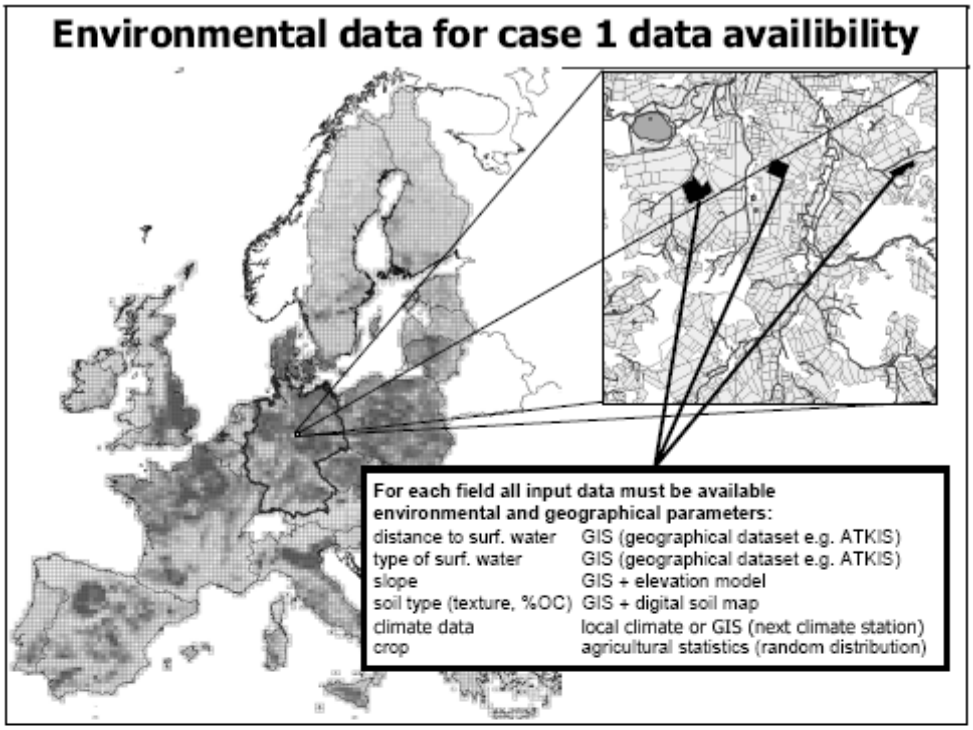


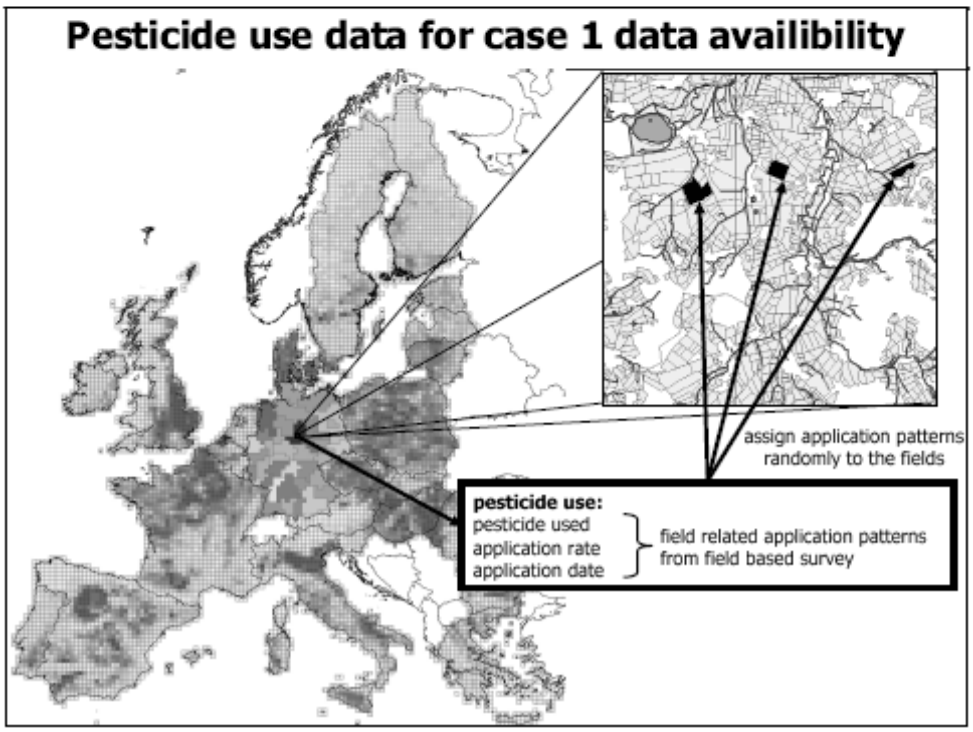
Calculation of *lPEC*: chronic risk

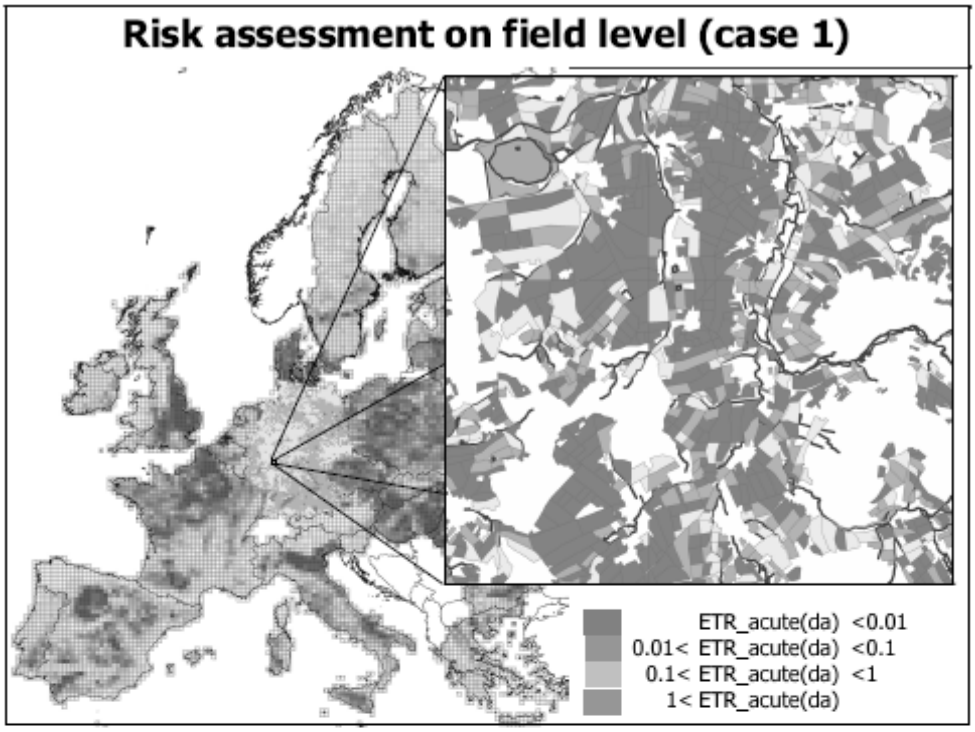


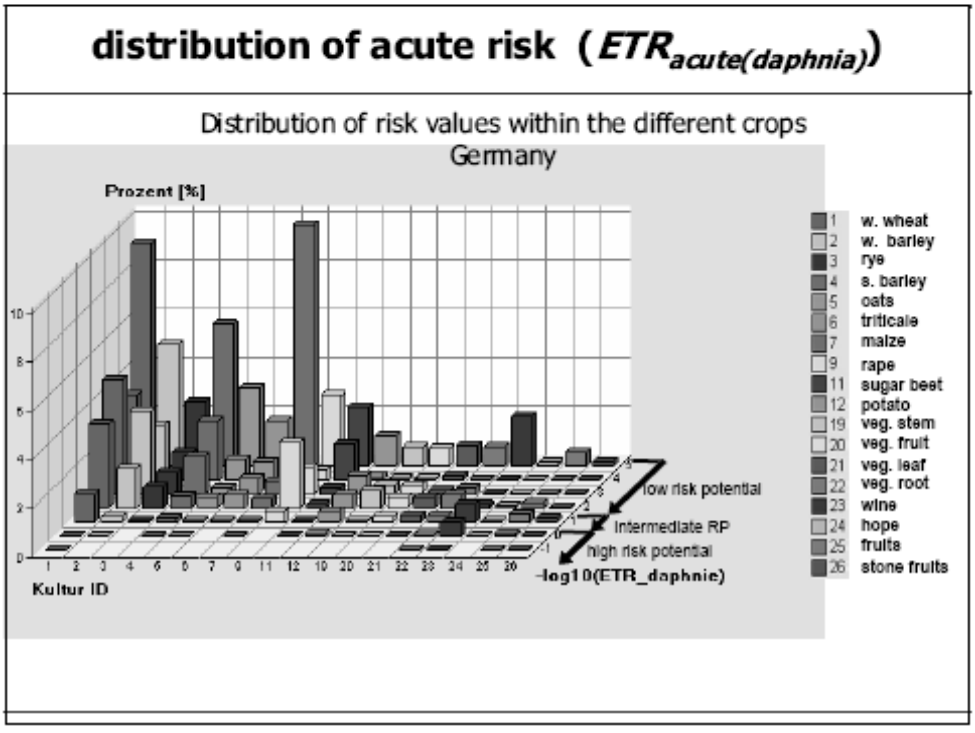
Three cases of data availability

	Pesticide use	application conditions	
		environment	crop
Case1	field related application patterns	field related	field related crops (random distribution according to agr. Statistics)
Case 2	crop related application patterns	regional	percentage of crop within a region
Case 3	volume of active ingredient applied per crop	regional	percentage of crop within a region


Environmental data for case 1 data availibility
For each field all input data must be available
environmental and geographical parameters:
distance to surf. water
GIS (geographical dataset e.g. ATKIS)
type of surf. water
GIS (geographical dataset e.g. ATKIS)
slope
GIS + elevation model
soil type (texture, %OC)
GIS + digital soil map
climate data
local climate or GIS (next climate station)
crop
agricultural statistics (random distribution)


Pesticide use data for case 1 data availibility
assign application patterns
randomly to the fields
pesticide use:
pesticide used
application rate
application date
field related application patterns
from field based survey


Risk assessment on field level (case 1)
ETR_acute(da) <0.01
0.01< ETR_acute(da) <0.1
0.1< ETR_acute(da) <1
1< ETR_acute(da)


distribution of acute risk (ETR acute(daphnia))
Distribution of risk values within the different crops
Germany
Prozent [%]
Kultur ID
low risk potential
intermediate RP
high risk potential
-log10(ETR_daphnie)
1 w. wheat
2 w. barley
3 rye
4 s. barley
5 oats
6 triticale
7 maize
9 rape
11 sugar beet
12 potato
19 veg. stem
20 veg. fruit
21 veg. leaf
22 veg. root
23 wine
24 hope
25 fruits
26 stone fruits

Spatial aggregation
acute risk potential for Daphnie ($ETR_{acute(daphnia)}$)

weighted mean

buffer zones are considered

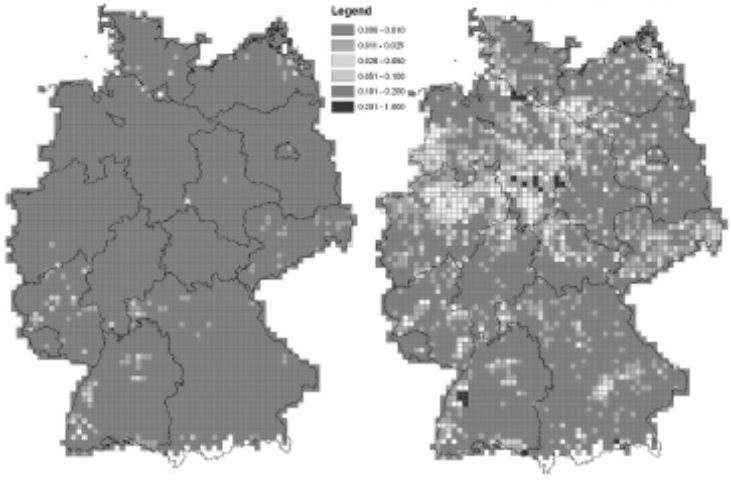
buffer zones are not considered

Spatial aggregation
acute risk potential for Daphnie ($ETR_{acute(daphnia)}$)

percentage of area with ETR_{acute}>1

buffer zones are considered

buffer zones are not considered



Summary Case 1

high resolution of basic risk events

regions with high risk potentials can be analyzed in detail

aggregation of risk potentials in all dimensions is possible

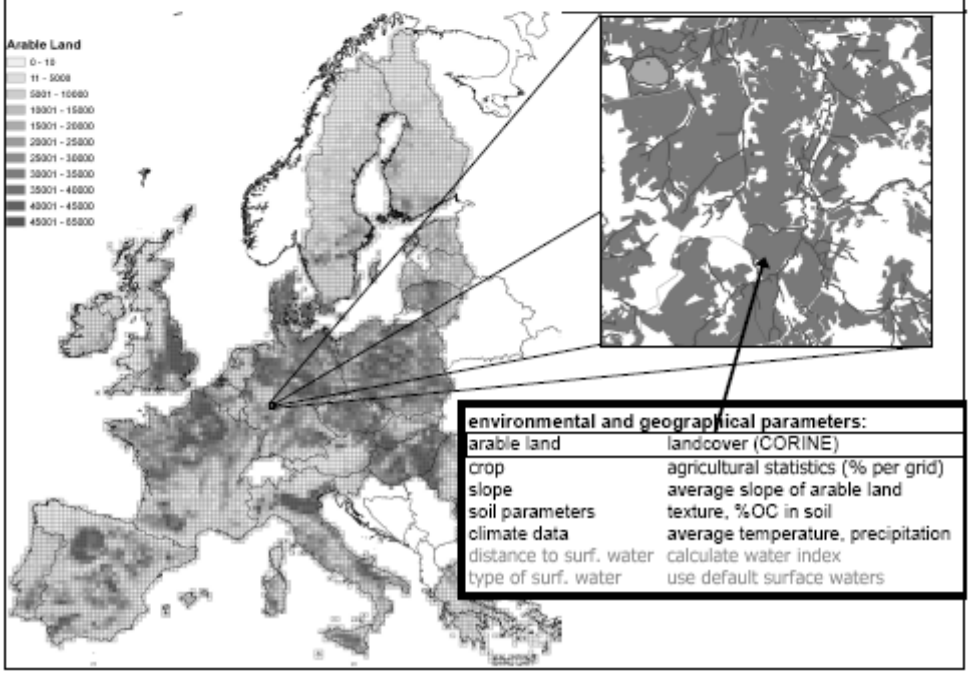
long calculation times are necessary

only possible if extended
geographical datasets are available

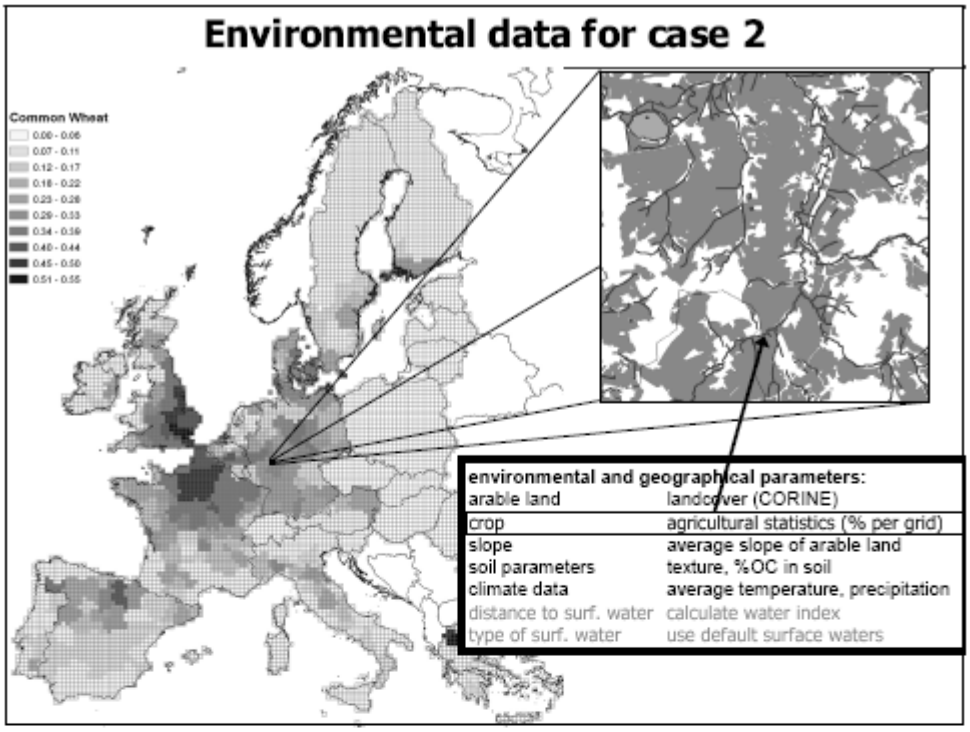
comparison of pesticide strategies using default environmental data

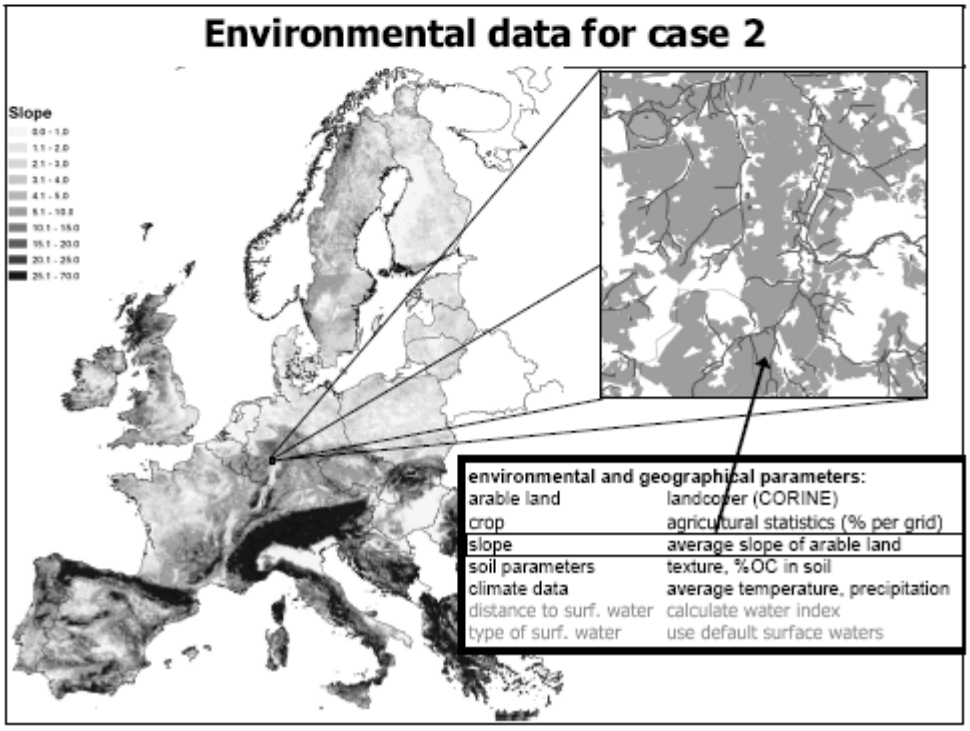
risk assessment on single farms / small regions
(manual data input)

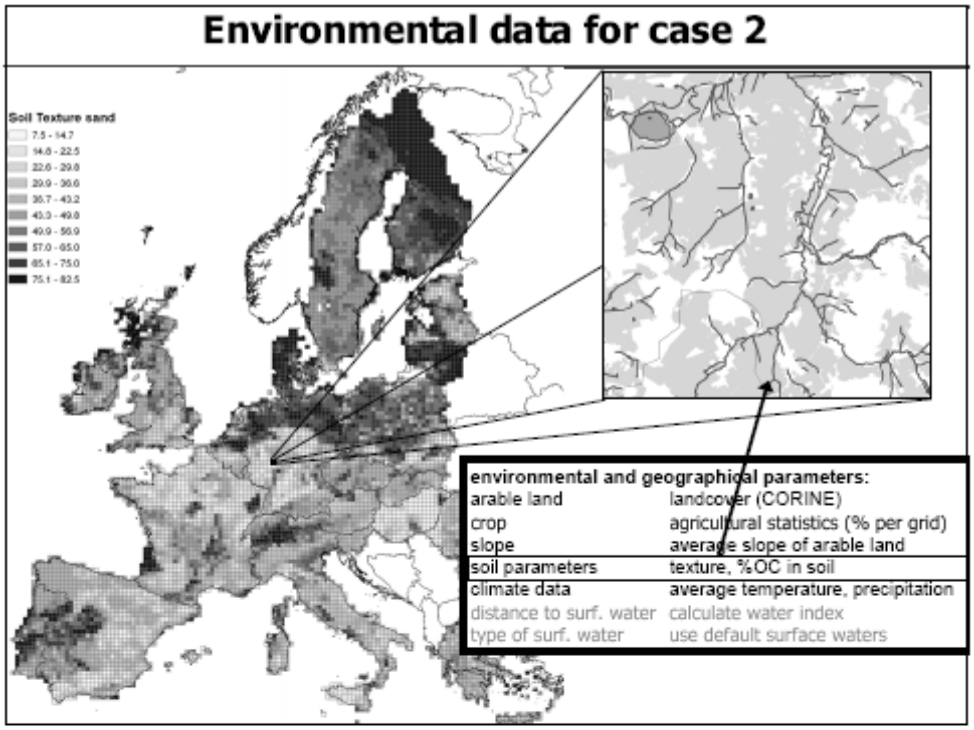
Environmental data for case 2

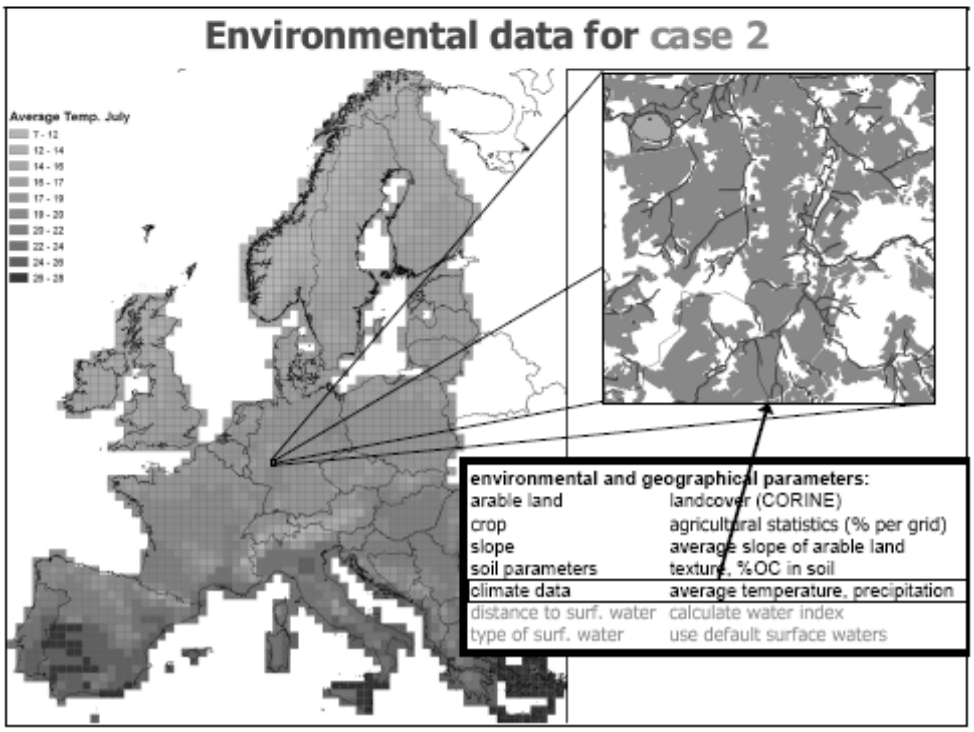


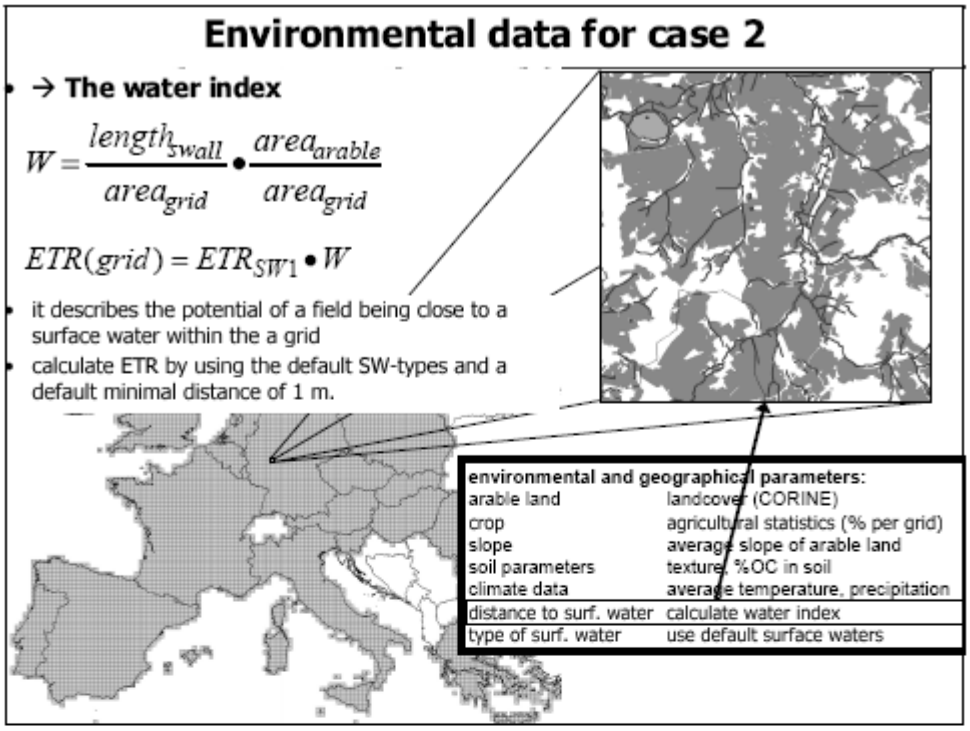
environmental and geographical parameters:	
arable land	landcover (CORINE)
crop	agricultural statistics (% per grid)
slope	average slope of arable land
soil parameters	texture, %OC in soil
climate data	average temperature, precipitation
distance to surf. water	calculate water index
type of surf. water	use default surface waters

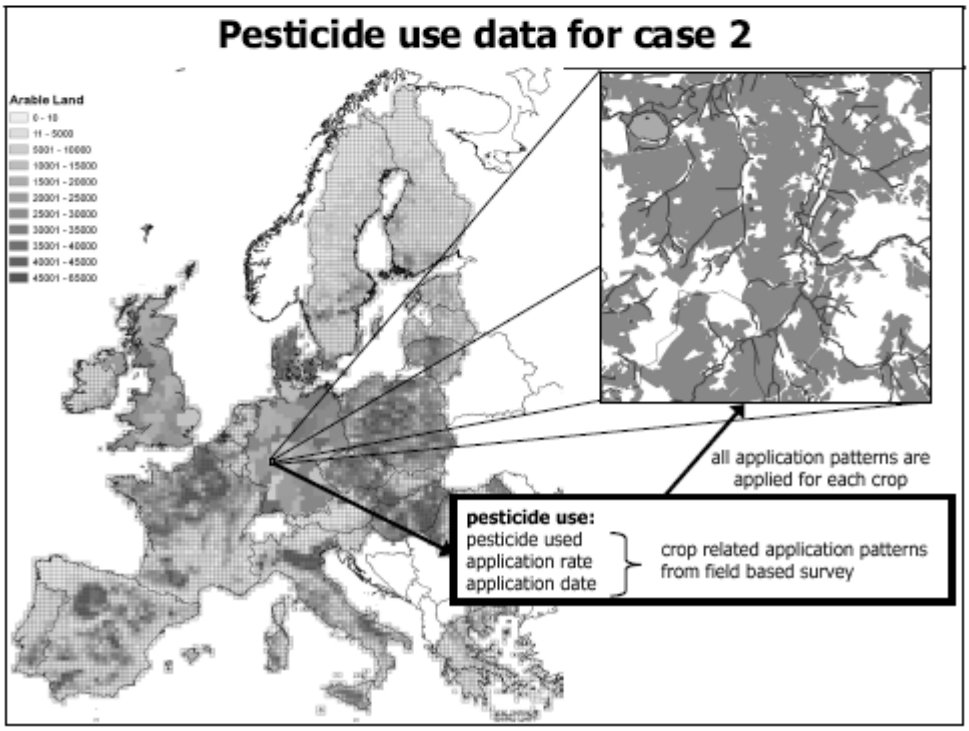

Environmental data for case 2
Common Wheat
0.00 - 0.06
0.07 - 0.11
0.12 - 0.17
0.18 - 0.22
0.23 - 0.28
0.29 - 0.33
0.34 - 0.39
0.40 - 0.44
0.45 - 0.50
0.51 - 0.55
environmental and geographical parameters:
arable land landcover (CORINE)
crop agricultural statistics (% per grid)
slope average slope of arable land
soil parameters texture, %OC in soil
climate data average temperature, precipitation
distance to surf. water calculate water index
type of surf. water use default surface waters


Environmental data for case 2
Slope
0.0 - 1.0
1.1 - 2.0
2.1 - 3.0
3.1 - 4.0
4.1 - 5.0
5.1 - 10.0
10.1 - 15.0
15.1 - 20.0
20.1 - 25.0
25.1 - 70.0
environmental and geographical parameters:
arable land landcover (CORINE)
crop agricultural statistics (% per grid)
slope average slope of arable land
soil parameters texture, %OC in soil
climate data average temperature, precipitation
distance to surf. water calculate water index
type of surf. water use default surface waters


Environmental data for case 2
Soil Texture sand
7.5 - 14.7
14.8 - 22.5
22.6 - 29.8
29.9 - 36.6
36.7 - 43.2
43.3 - 49.8
49.9 - 56.9
57.0 - 65.0
65.1 - 75.0
75.1 - 82.5
environmental and geographical parameters:
arable land landcover (CORINE)
crop agricultural statistics (% per grid)
slope average slope of arable land
soil parameters texture, %OC in soil
climate data average temperature, precipitation
distance to surf. water calculate water index
type of surf. water use default surface waters

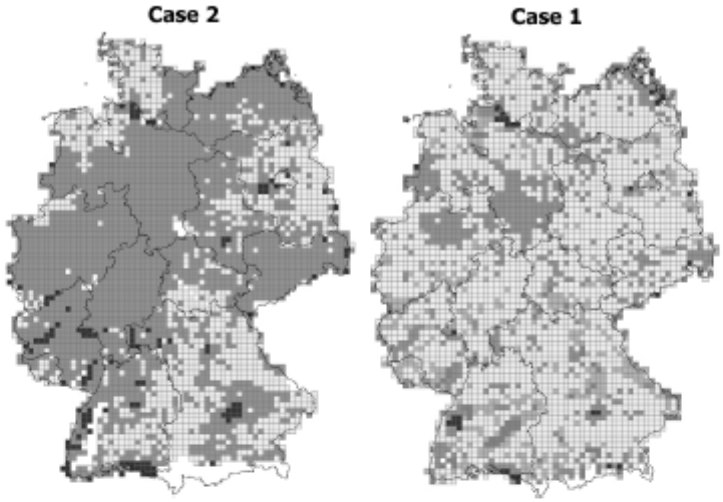

Environmental data for case 2
Average Temp. July
7 - 12
12 - 14
14 - 16
16 - 17
17 - 19
19 - 20
20 - 22
22 - 24
24 - 26
26 - 28
environmental and geographical parameters:
arable land landcover (CORINE)
crop agricultural statistics (% per grid)
slope average slope of arable land
soil parameters texture, %OC in soil
climate data average temperature, precipitation
distance to surf. water calculate water index
type of surf. water use default surface waters


Environmental data for case 2
→ The water index
$W = \frac{length_{swall}}{area_{grid}} \bullet \frac{area_{arable}}{area_{grid}}$
$ETR(grid) = ETR_{SW1} \bullet W$
it describes the potential of a field being close to a surface water within the a grid
calculate ETR by using the default SW-types and a default minimal distance of 1 m.
environmental and geographical parameters:
arable land — landcover (CORINE)
crop — agricultural statistics (% per grid)
slope — average slope of arable land
soil parameters — texture, %OC in soil
climate data — average temperature, precipitation
distance to surf. water — calculate water index
type of surf. water — use default surface waters


Pesticide use data for case 2
Arable Land
0 - 10
11 - 5000
5001 - 10000
10001 - 15000
15001 - 20000
20001 - 25000
25001 - 30000
30001 - 35000
35001 - 40000
40001 - 45000
45001 - 65000
all application patterns are applied for each crop
pesticide use:
pesticide used
application rate
application date
crop related application patterns from field based survey

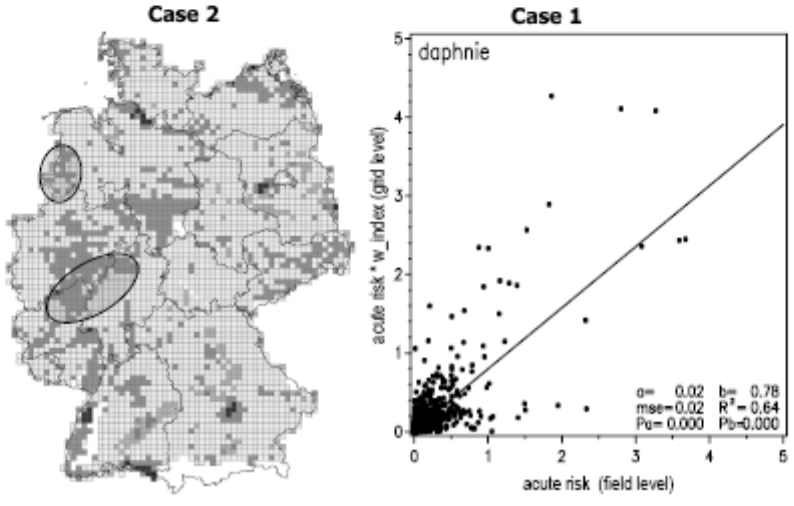
Comparison of the acute risk indicator calculated with case1 and case2 data availability

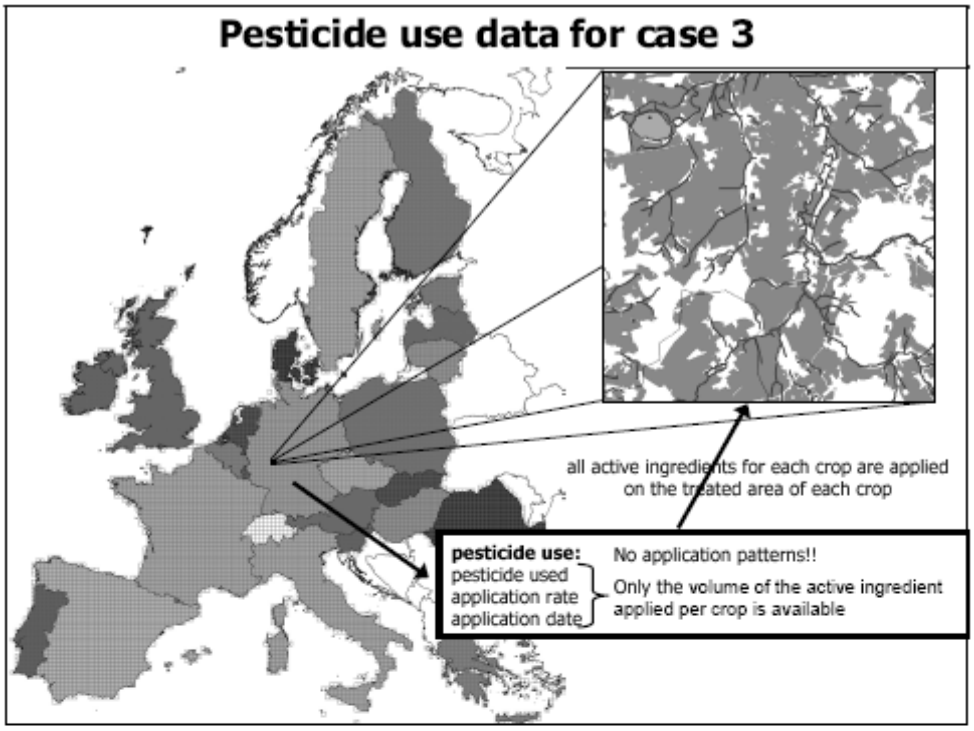
$ETR_{acute(daphnia)}$ was calculated without multiplying by the water index

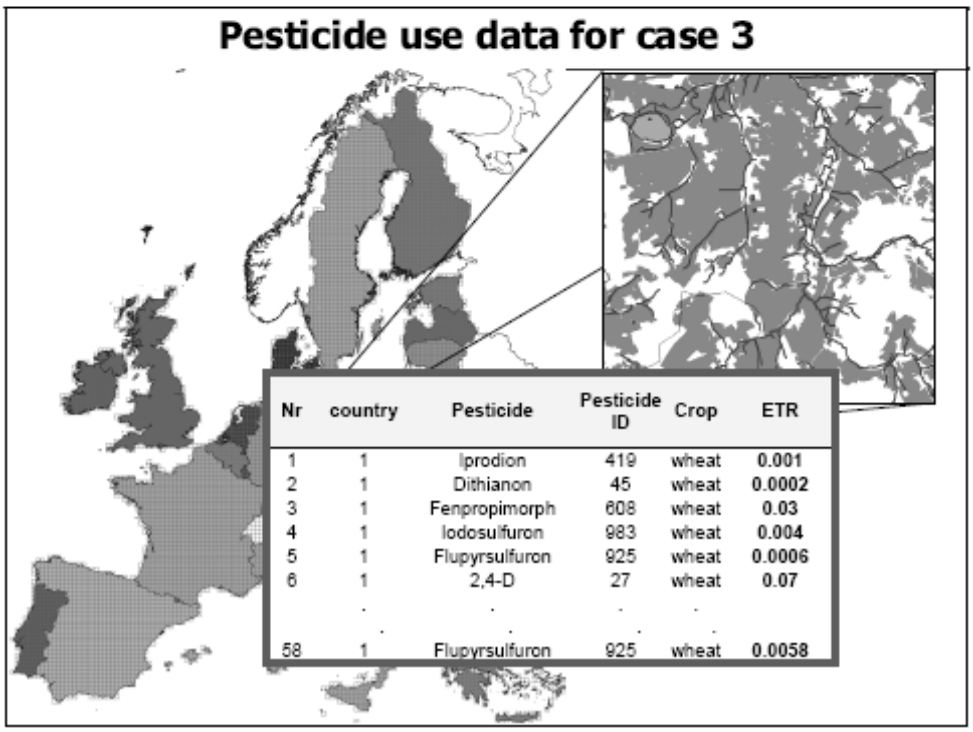


Comparison of the acute risk indicator calculated with case1 and case2 data availability

$ETR_{acute(daphnia)}$ was calculated multiplying by the **water index**




Pesticide use data for case 3
all active ingredients for each crop are applied on the treated area of each crop
pesticide use:
pesticide used
application rate
application date
No application patterns!!
Only the volume of the active ingredient applied per crop is available

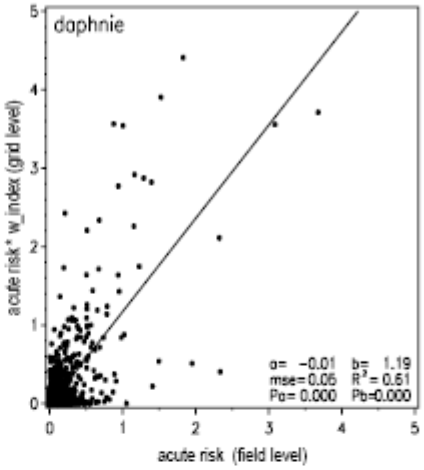

Pesticide use data for case 3
Nr country Pesticide Pesticide ID Crop ETR
1 1 Iprodion 419 wheat 0.001
2 1 Dithianon 45 wheat 0.0002
3 1 Fenpropimorph 608 wheat 0.03
4 1 Iodosulfuron 983 wheat 0.004
5 1 Flupyrsulfuron 925 wheat 0.0006
6 1 2,4-D 27 wheat 0.07
58 1 Flupyrsulfuron 925 wheat 0.0058

Comparison of the acute risk indicator calculated with case1 and case3 data availability

$ETR_{acute(daphnia)}$ was calculated multiplying by the **water index**

Case 3

Case 1



Summary Case 2 and Case3

- Results are already aggregated on grid level → Fewer possibilities of aggregating and interpreting the risk indices.
- all necessary environmental data are available on 10*10 km and 25*25 km grid basis.
- CASE2: Regional differences of pesticide use can be analyzed within the member states
- CASE3: Best used for national trends
- Influence of water index has to be further evaluated
- Differences in the results of the 3 cases have to be further analyzed

0

HArmonized environmental Indicators for pesticide Risk

WP 6: Terrestrial risk indicators

CENTRAL SCIENCE LABORATORY, UK
Villie Flari
David Ronald Crocker
Andy Hart

THE UNIVERSITY of York
Roman Ashauer
Colin Brown

Research Institute for Organic Agriculture (FiBL), Switzerland
Andreas Fliessbach

Terrestrial risk indicators

- Outline of assessed (& not assessed) risks and groups of organisms
- Outline of the plan of the indicators, incl. output and possible outcomes
- Example: detailed presentation, incl. algorithms, of bird acute and chronic risk indicator
- Aggregation policy in terrestrial risk indicator work package
- Example: inclusion of usage data
- Conclusions

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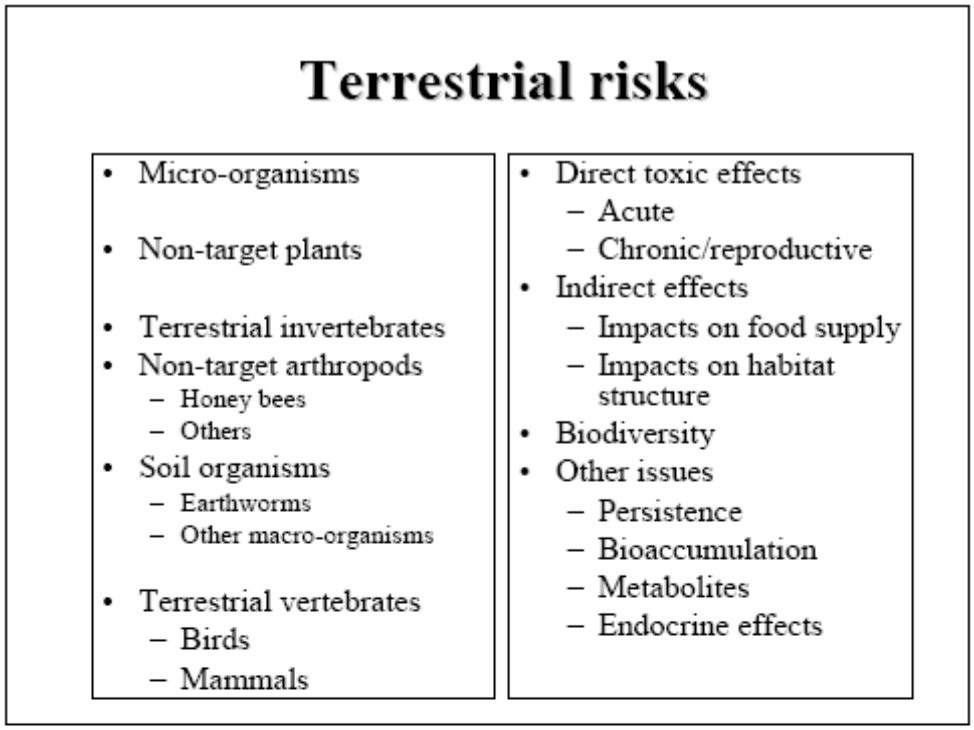
- Example: detailed presentation, incl. algorithms, of bird acute and chronic risk indicators
- Examples: inclusion of usage data - aggregation along time, space, actives
- Aggregation in terrestrial risk indicator work package
- Further indicators and conclusions / possible shortfalls

Terrestrial risks

- Micro-organisms
- Non-target plants
- Terrestrial invertebrates
- Non-target arthropods
  - Honey bees
  - Others
- Soil organisms
  - Earthworms
  - Other macro-organisms
- Terrestrial vertebrates
  - Birds
  - Mammals

- Direct toxic effects
  - Acute
  - Chronic/reproductive
- Indirect effects
  - Impacts on food supply
  - Impacts on habitat structure
- Biodiversity
- Other issues
  - Persistence
  - Bioaccumulation
  - Metabolites
  - Endocrine effects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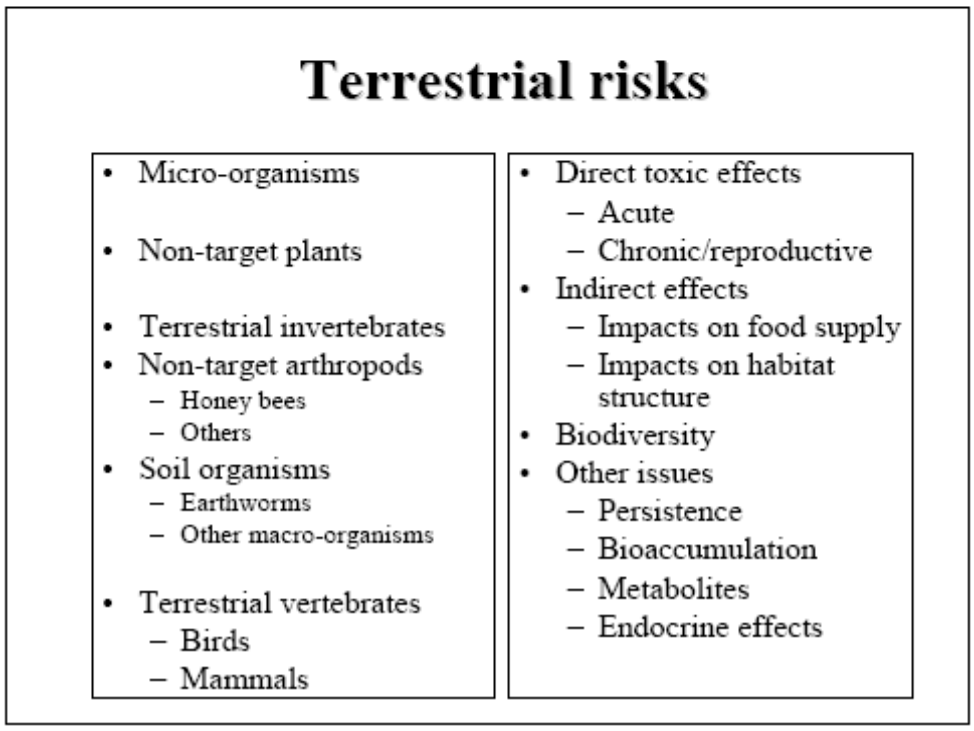
Terrestrial risks
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Plan of terrestrial risk indicators

Based upon most recent regulatory approaches

Plan of terrestrial risk indicators

Based upon most recent regulatory approaches

- **SANCO/10329/2002: Guidance document on Terrestrial Ecotoxicology under Uniform Principles of EU Directive 91/414**
- **SANCO/4145/2000: Guidance document on Terrestrial Risk Assessment for Birds and Mammals under Uniform Principles of EU Directive 91/414**

Plan of terrestrial risk indicators

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- **EPPO Decision Making Schemes, 2003**

Plan of terrestrial risk indicators

- **Basic Risk Indicator**
- **Design: Reflects first tier regulatory decision making schemes**

Plan of terrestrial risk indicators

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- **Advanced Risk Indicator**
- **Refined as HIGHER TIER is introduced**

Plan of terrestrial risk indicators

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Output

Exposure to Toxicity ratio : ETR

Plan of terrestrial risk indicators

- Basic Risk Indicator
- Design: Reflects first tier regulatory decision making schemes

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- Refined as HIGHER TIER is introduced

Output

Exposure to Toxicity ratio : ETR

Outcome

USAGE DATA

Plan of terrestrial risk indicators

- Basic Risk Indicator
- Design: Reflects first tier regulatory decision making schemes

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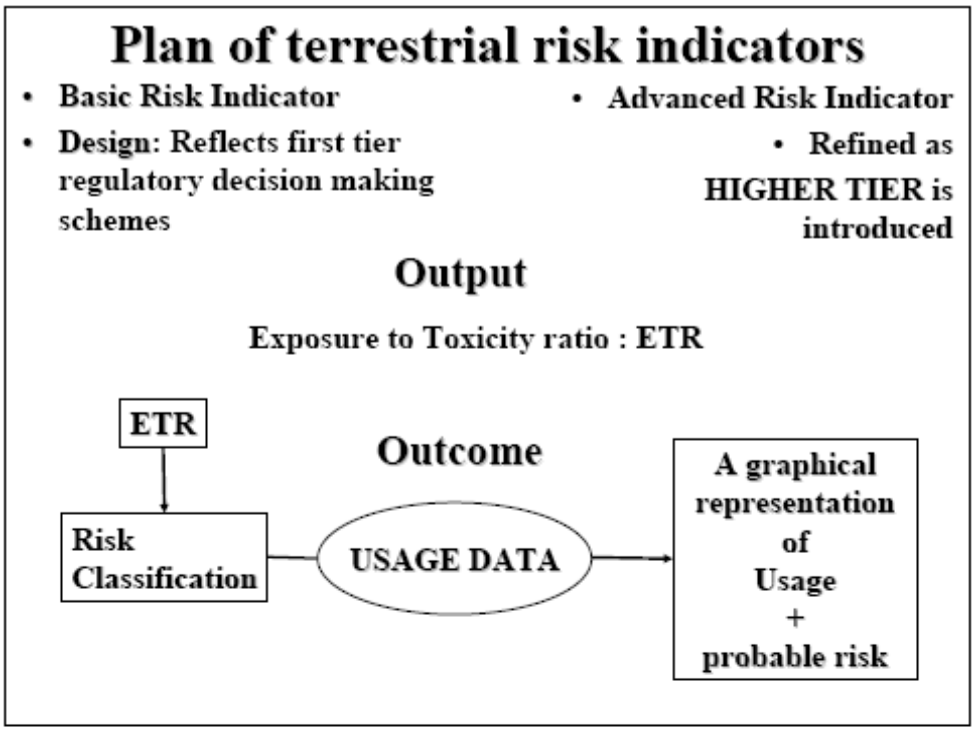
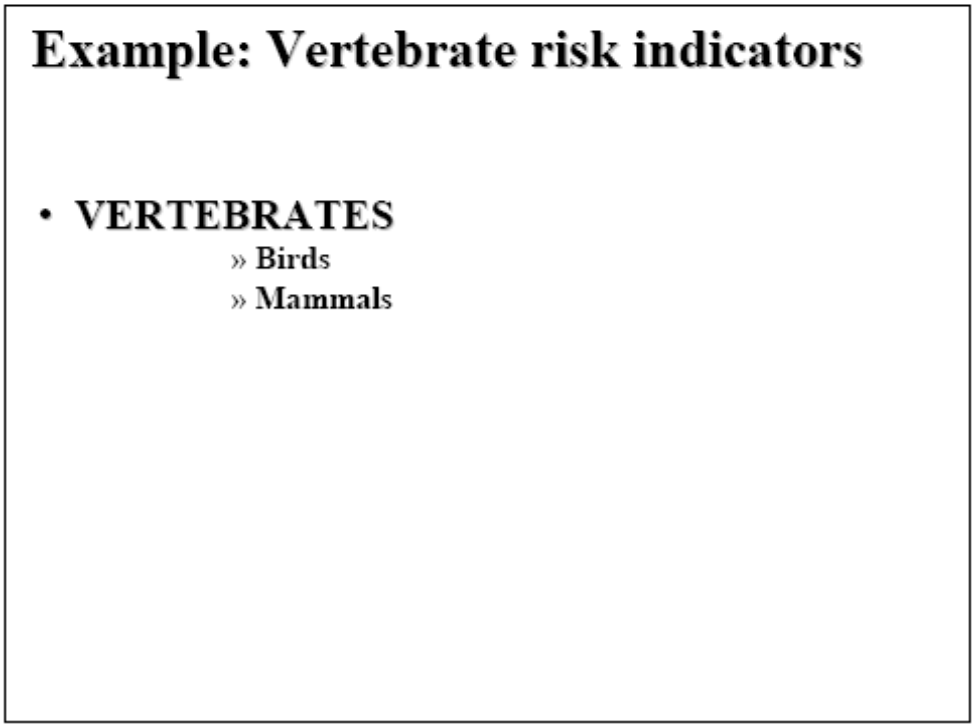
- Refined as HIGHER TIER is introduced

Output

Exposure to Toxicity ratio : ETR

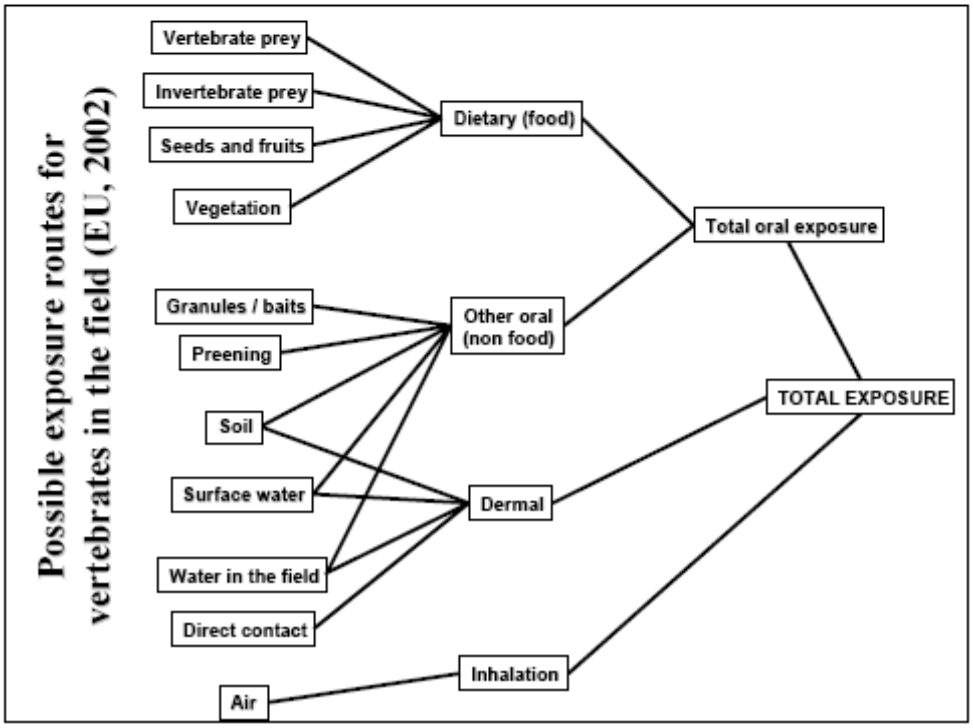
Outcome

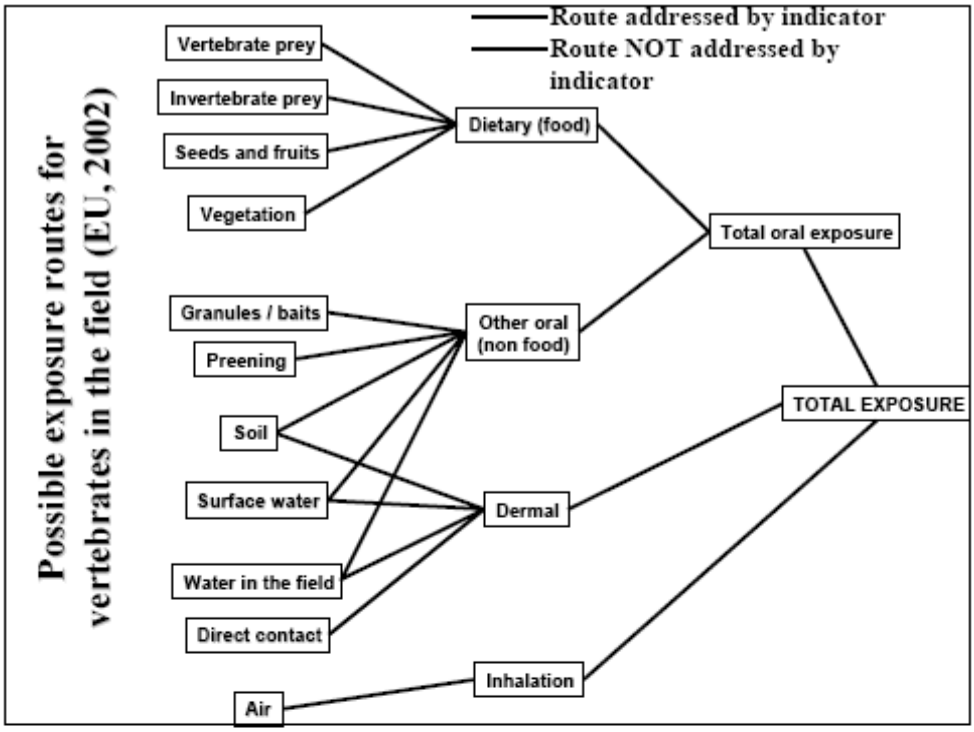

Plan of terrestrial risk indicators
• Basic Risk Indicator
• Design: Reflects first tier regulatory decision making schemes
• Advanced Risk Indicator
• Refined as HIGHER TIER is introduced
Output
Exposure to Toxicity ratio : ETR
ETR
Outcome
Risk Classification
USAGE DATA
A graphical representation of Usage + probable risk


Example: Vertebrate risk indicators
• VERTEBRATES
» Birds
» Mammals

Example: Bird risk indicators

- **VERTEBRATES**
  - » Birds
  - » Mammals





BAsic Bird Risk Indicator
Phase I: Estimation of Exposure

Estimated Theoretical Exposure (ETE)

or

Daily Dietary Dose (DDD)

BAsic Bird Risk Indicator
Phase I: Estimation of Exposure

Estimated Theoretical Exposure (ETE)

or

Daily Dietary Dose (DDD)

Reasonable Worst Case (RWC)
(as introduced in EU Guidance Documents

BAsic Bird Risk Indicator
Phase I: Estimation of Acute Exposure

Estimated Theoretical Exposure (ETE)

or

Daily Dietary Dose (DDD)

Reasonable Worst Case (RWC)
(as introduced in EU Guidance Documents & EPPO, 2003)

Most Likely Case (MLC)
(as introduced in EPPO, 2003)

BAsic Bird Risk Indicator
Phase I: Estimation of Exposure

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or

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Reasonable Worst Case (RWC)
(as introduced in EU Guidance Documents & EPPO, 2003)

Most Likely Case (MLC)
(as introduced in EPPO, 2003)

- **Crop**
- **Bird indicator species**
- **Exposure standard scenario**

BAsic Bird Risk Indicator
Phase I: Estimation of Exposure
a. Crop ⟶ Indicator species

Reasonable Worst Case (RWC)

Most Likely Case (MLC)

BAsic Bird Risk Indicator

Phase I: Estimation of Exposure
a. Crop ⟶ Indicator species

Reasonable Worst Case (RWC)	Most Likely Case (MLC)
Herbivorous (3000g)	Herbivorous (3000g)
Insectivorous (10g)	

BAsic Bird Risk Indicator

Phase I: Estimation of Exposure
a. Crop ⟶ Indicator species

Reasonable Worst Case (RWC)	Most Likely Case (MLC)
Herbivorous (3000g)	Herbivorous (3000g)
Insectivorous (10g)	
Herbivorous (300g)	Omnivorous (300g)

BAsic Bird Risk Indicator

Phase I: Estimation of Exposure
a. Crop ⟶ Indicator species

Reasonable Worst Case (RWC)	Most Likely Case (MLC)
Herbivorous (3000g) Cereal shoots Insectivorous (10g) Insects	Herbivorous (3000g) Cereal shoots
Herbivorous (300g) Non-grass herbs	Omnivorous (300g) 33% non-grass herbs 33% insects 33% seeds

BAsic Bird Risk Indicator

Phase I: Estimation of Exposure
b. Standard scenario

•Spraying

•Seed treatment

•Granular application

BAsic Bird Risk Indicator

Phase I: Estimation of Exposure
b. Standard scenario

•Spraying

•Seed treatment

•Granular application

•INTENTIONALLY
- ➢as food
- ➢as grit

•ACCIDENTALLY
- ➢through soil consumption
- ➢as weed seeds

BAsic Bird Risk Indicator

Phase I: Estimation of Exposure
b. Standard scenario

•Spraying

•Seed treatment

•Granular application

•INTENTIONALLY
- ➢as food
- ➢as grit

•ACCIDENTALLY
- ➢through soil consumption
- ➢as weed seeds

BAsic Bird Risk Indicator
Phase I: Estimation of Acute Exposure
c. Calculations (Crocker *et al.*, 2002)

Estimated Theoretical Exposure (ETE) or **Daily Dietary Dose (DDD)**

BAsic Bird Risk Indicator
Phase I: Estimation of Acute Exposure
c. Calculations (Crocker *et al.*, 2002)

Estimated Theoretical Exposure (ETE) or **Daily Dietary Dose (DDD)**

ETE= [FIR/BW]*C*AV*PT*PD **[mg a.s./kg BW/day]**

FIR: **Food Intake Rate** **[g fresh weight food/day]**

C: **Concentration** **[mg a.s./kg fresh weight food]**

BW: **Body Weight** **[g]**

		RWC	MLC
AV:	**Avoidance**	**1**	**1**
PT:	**proportion of diet from treated area**	**1**	**0.5**
PD	**proportion of food type in diet**	**1**	**Depends on species**

BAsic Bird Risk Indicator
Phase I: Estimation of Acute Exposure
c. Calculations (Crocker *et al.*, 2002)

Estimated Theoretical Exposure (ETE) or **Daily Dietary Dose (DDD)**

ETE=	**[FIR/BW]*C*AV*PT*PD**		**[mg a.s./kg BW/day]**
	FIR:	**DEE/[FE*(1-MC/100)*(AE/100)]**	**[g fresh weight food/day]**
	DEE:	Daily Energy Expenditure	[kJ/day]
	FE:	Food Energy	[kJ/g dry weight food]
	MC:	Moisture content	[%]
	AE:	Assimilation Efficiency	[%]
	C:	**RUD*AR*MAF**	**[mg a.s./kg fresh weight food]**
	RUD:	Residue Unit Dose [normalised for 1kg a.s. on 1 ha]	[mg a.s. / kg fresh weight food]
	AR:	Application Rate	[kg a.s. / ha]
	MAF:	Multiple Application Factors	
			RWC MLC
	AV:	Avoidance	1 1
	PT:	proportion of diet from treated area	1 0.5
	PD	proportion of food type in diet	1 Depends on species

BAsic Bird Risk Indicator
Phase I: Estimation of Acute Exposure
c. Calculations (Crocker *et al.*, 2002)

Estimated Theoretical Exposure (ETE) or **Daily Dietary Dose (DDD)**

ETE=	**[FIR/BW]*C*AV*PT*PD**		**[mg a.s./kg BW/day]**
	FIR:	**DEE/[FE*(1-MC/100)*(AE/100)]**	**[g fresh weight food/day]**
	DEE:	Daily Energy Expenditure	[kJ/day]
	FE:	Food Energy	[kJ/g dry weight food]
	MC:	Moisture content	[%]
	AE:	Assimilation Efficiency	[%]
	C:	**RUD*AR*MAF**	**[mg a.s./kg fresh weight food]**
	RUD:	Residue Unit Dose [normalised for 1kg a.s. on 1 ha]	[mg a.s. / kg fresh weight food]
		RWC MLC	
		90^{th} 50^{th}	
	AR:	Application Rate	[kg a.s. / ha]
	MAF:	Multiple Application Factors: 90^{th}	
			RWC MLC
	AV:	Avoidance	1 1
	PT:	proportion of diet from treated area	1 0.5
	PD	proportion of food type in diet	1 Depends on species

BAsic Bird Risk Indicator
Phase I: Estimation of Chronic Exposure
c. Calculations (Crocker *et al.*, 2002)

Estimated Theoretical Exposure (ETE) - sum for 3 weeks

ETE=	[FIR/BW]*C*AV*PT*PD		[mg a.s./kg BW/day]
	FIR:	DEE/[FE*(1-MC/100)*(AE/100)]	[g fresh weight food/day]
	DEE:	Daily Energy Expenditure	[kJ/day]
	FE:	Food Energy	[kJ/g dry weight food]
	MC:	Moisture content	[%]
	AE:	Assimilation Efficiency	[%]
	C:	C_0*MAF*f_{twa}	[mg a.s./kg fresh weight food]
	AR:	Application Rate	[kg a.s. / ha]
			RWC / MLC
	AV:	Avoidance	1 / 1
	PT:	proportion of diet from treated area	1 / 0.5
	PD	proportion of food type in diet	1 / Depends on species

BAsic Bird Risk Indicator
Phase I: Estimation of Chronic Exposure
c. Calculations (Crocker *et al.*, 2002)

Estimated Theoretical Exposure (ETE) - sum for 3 weeks

ETE=	[FIR/BW]*C*AV*PT*PD		[mg a.s./kg BW/day]
	FIR:	DEE/[FE*(1-MC/100)*(AE/100)]	[g fresh weight food/day]
	DEE:	Daily Energy Expenditure	[kJ/day]
	FE:	Food Energy	[kJ/g dry weight food]
	MC:	Moisture content	[%]
	AE:	Assimilation Efficiency	[%]
	C:	C_0*MAF*f_{twa}	[mg a.s./kg fresh weight food]
	AR:	Application Rate	[kg a.s. / ha]
			RWC / MLC
	AV:	Avoidance	1 / 1
	PT:	proportion of diet from treated area	1 / 0.5
	PD	proportion of food type in diet	1 / Depends on species

BAsic Bird Risk Indicator

•Vegetation: exponential degradation is assumed

C: $C_0 * MAF * f_{twa}$ [mg a.s. / kg fresh weight food]
Co: Initial concentration after a single application [mg a.s. / kg fresh weight food]

MAF: Multiple Application Factors
Deterministic in EU based on DT_{50}=10 days

$$MAF = \frac{1 - e^{0.069ni}}{1 - e^{0.069i}}$$

n=number of applications
i=interval between applications

f_{twa} : Time Weighted Averaged Factors when DT_{50}<10 days

$$f_{twa} = \frac{1 - e^{-kt}}{k * t}$$

k=ln2/DT_{50} velocity constant
t=averaging time

BAsic Bird Risk Indicator

•Insects: degradation is not known
population movements are not modelled

•Seeds: degradation is not known

Deterministic value		
Arithmetic mean	Large insects	5.1 mg/kg
	Small insects	29.0 mg/kg
Probabilistic value	Distribution	
	e.g. as in Roelofs *et al.*, 2005	

BAsic Bird Risk Indicator

Phase II: Estimation of Toxicity
a. Toxicity figures

Lowest toxicity figure
Geometric Mean, e.g.: When >1 LD_{50} or NOEC for same species

Chronic
LC_{50} or GM LC_{50} ⟶ Daily Dose [mg a.s. / kg BW / day]

$(LC_{50}$*FIR)/BW

BAsic Bird Risk Indicator

Phase II: Estimation of Toxicity
b. Extrapolation factors

Number of species for which LD_{50} are available

<6 **≥ 6**

BAsic Bird Risk Indicator

Phase II: Estimation of Toxicity
b. Extrapolation factors

Number of species for which LD_{50} are available

<6 (Luttik & Aldenberg, 1997)

≥ 6

5th percentile SSD=$GM_{toxicity\ figure}$/EF

GM: Geometric Mean
EF: Extrapolation Factor

EFs for: median
95% CL

BAsic Bird Risk Indicator

Phase II: Estimation of Toxicity
b. Extrapolation factors

Number of species for which LD_{50} are available

<6 (Luttik & Aldenberg, 1997)

≥ 6 (Aldenberg & Slob, 1993)

5th percentile SSD =$GM_{toxicity\ figure}$/EF

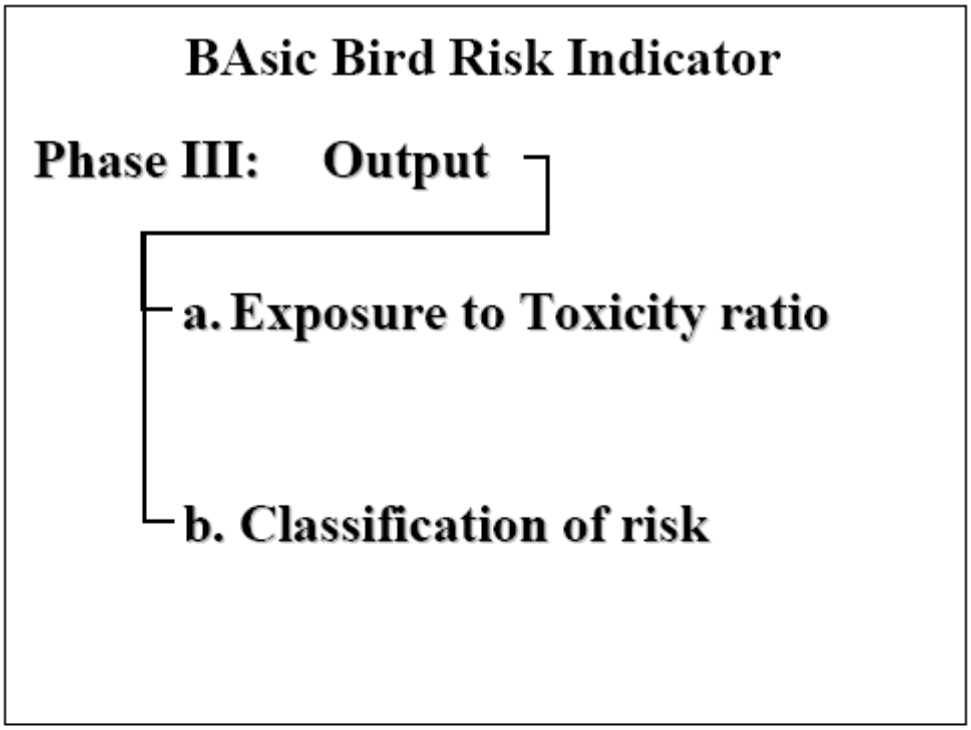
5th percentile SSD=10 $^{(log\ mean_{toxicity\ figure}-EF*SD)}$

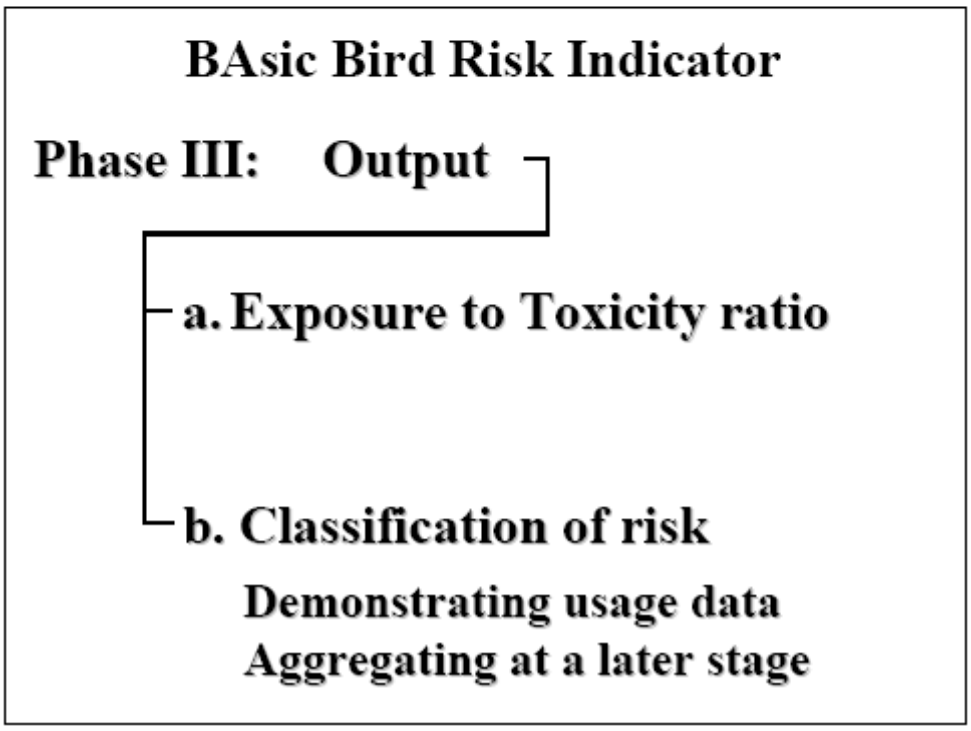
GM: Geometric Mean
EF: Extrapolation Factor

EF: Extrapolation Factor
SD: Standard $Deviation_{toxicity\ figure}$

EFs for: median
95% CL

EFs for: median
95% CL


BAsic Bird Risk Indicator
Phase III: Output
a. Exposure to Toxicity ratio
b. Classification of risk


BAsic Bird Risk Indicator
Phase III: Output
a. Exposure to Toxicity ratio
b. Classification of risk
Demonstrating usage data
Aggregating at a later stage

Worked examples

AR (kg/ha)	ETR	[3]Toxicity figure		
3.255		1	0.32	[1]Root crops -[4]Aldicarb
0.25		5826	188.7	[2]Wheat -[5]Carbendazim
0.72		32	3.6	[2]Wheat -[5]Chlorpyrifos
0.675		10.50	0.9	[2]Wheat –[5]Dimethoate

[1] Granules consumed intentionally as grit
[2] Spraying standard scenario
[3] Lowest (or single) LD_{50} or 5th percentile SSD
[4] **RWC-MLC:** Herbivorous (300g)
[5] **RWC-MLC:** Herbivorous (3000g)

Worked examples

AR (kg/ha)	ETR	[3]Toxicity figure		
3.255		1	0.32	[1]Root crops -[4]Aldicarb
0.25		5826	188.7	[2]Wheat -[5]Carbendazim
0.72		32	3.6	[2]Wheat -[5]Chlorpyrifos
0.675		10.50	0.9	[2]Wheat –[5]Dimethoate

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[3] Lowest (or single) LD_{50} or 5th percentile SSD
[4] **RWC-MLC:** Herbivorous (300g)
[5] **RWC-MLC:** Herbivorous (3000g)

ETR_{RWC}>1

Worked examples

Assessed by the BAsic Birds Risk Indicator

AR (kg/ha)	ETR_{RWC}	[3]Toxicity figure	Classification of risk
3.255	[1]1012.54	1	[4]Aldicarb
0.25	[3]0.015	5826	Low risk [5]Carbendazim
0.72	[3]2.07	32	[5]Chlorpyrifos
0.675	[3]5.73	10.50	[5]Dimethoate

[1] Granules consumed intentionally as grit
[2] Spraying standard scenario
[3] Lowest (or single) LD_{50} (RWC) or 5th percentile SSD (MLC)
[4] **RWC-MLC:** Herbivorous (300g)
[5] **RWC-MLC:** Herbivorous (3000g)

ETR_{RWC}>1

Worked examples

Assessed by the BAsic Birds Risk Indicator

AR (kg/ha)	ETR_{RWC}	[3]Toxicity figure	Classification of risk
3.255	[1]1012.54	1	High risk [4]Aldicarb
0.25	[3]0.015	5826	Low risk [5]Carbendazim
0.72	[3]2.07	32	High risk [5]Chlorpyrifos
0.675	[3]5.73	10.50	High risk [5]Dimethoate

[1] Granules consumed intentionally as grit
[2] Spraying standard scenario
[3] Lowest (or single) LD_{50} (RWC) or 5th percentile SSD (MLC)
[4] **RWC-MLC:** Herbivorous (300g)
[5] **RWC-MLC:** Herbivorous (3000g)

$ETR_{RWC}>1$

Worked examples

Assessed by the BAsic Birds Risk Indicator

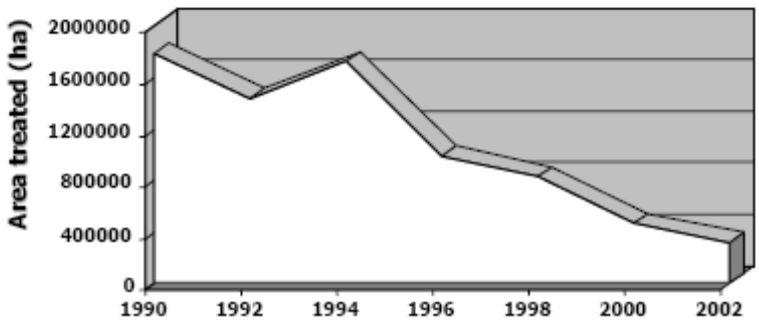
AR (kg/ha)	ETR_{RWC}	[3]Toxicity figure	Classification of risk
3.255	[1]1012.54	1	Risk requiring refined assessment and/or mitigation [4]Aldicarb
0.25	[3]0.015	5826	Risk below screening level [5]Carbendazim
0.72	[3]2.07	32	Risk requiring refined assessment and/or mitigation [5]Chlorpyrifos
0.675	[3]5.73	10.50	Risk requiring refined assessment and/or mitigation [5]Dimethoate

[1] Granules consumed intentionally as grit
[2] Spraying standard scenario
[3] Lowest (or single) LD_{50} (RWC) or 5th percentile SSD (MLC)
[4] **RWC-MLC:** Herbivorous (300g)
[5] **RWC-MLC:** Herbivorous (3000g)

Worked examples - Output of BAsic Bird Risk Indicator combined with pesticide usage data: aggregation along time, space, actives

Usage data of Aldicarb, Carbendazim, Chlorpyrifos and Dimethoate on Wheat, Potatoes and Sugar Beet crops in the UK: 1990-2002

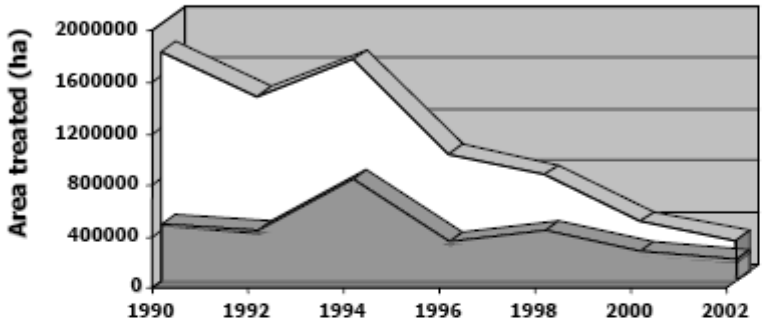
▫Total area treated (ha)



Worked examples - Output of BAsic Bird Risk Indicator combined with pesticide usage data: aggregation along time, space, actives

Usage data of Aldicarb, Carbendazim, Chlorpyrifos and Dimethoate on Wheat, Potatoes and Sugar Beet crops in the UK: 1990-2002

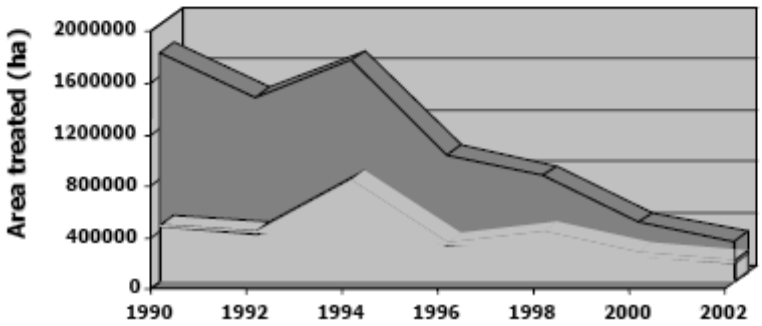
- Total area treated (ha)
- Area for which risk is requiring refined assessment and/or mitigation



Worked examples - Output of BAsic Bird Risk Indicator combined with pesticide usage data: aggregation along time, space, actives

Usage data of Aldicarb, Carbendazim, Chlorpyrifos and Dimethoate on Wheat, Potatoes and Sugar Beet crops in the UK: 1990-2002

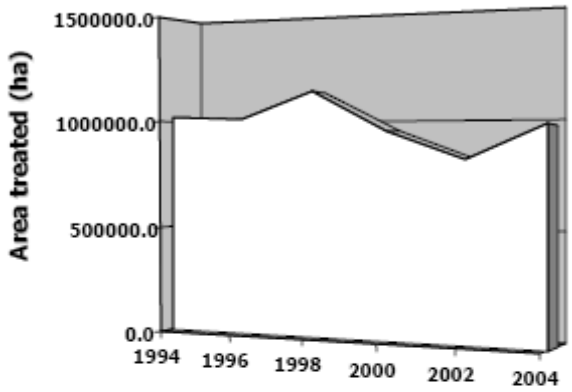
- Area for which risk is below screening
- Area for which risk is requiring refined assessment and/or mitigation



Worked examples - Output of Chronic Risk Earthworm Indicator combined with pesticide usage data: aggregation along time, space, actives

Usage data of Spiroxamine, Triadimenol and Trifluralin on Wheat crops in the UK: 1992-2004

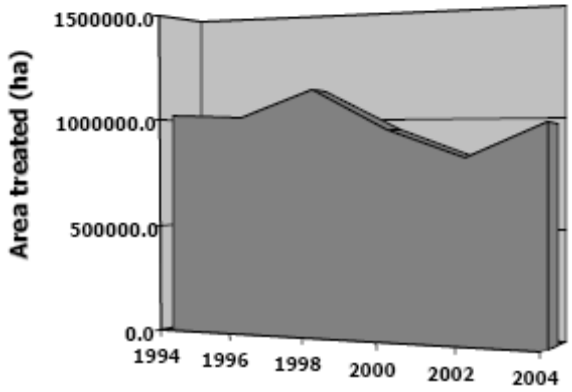
Total area treated (ha)

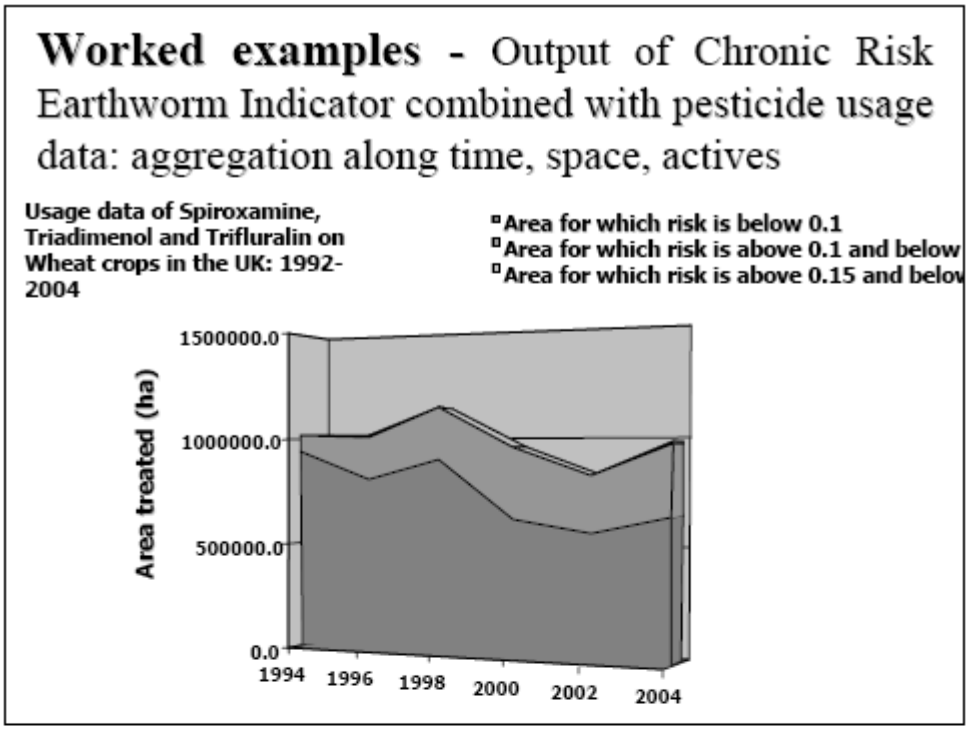


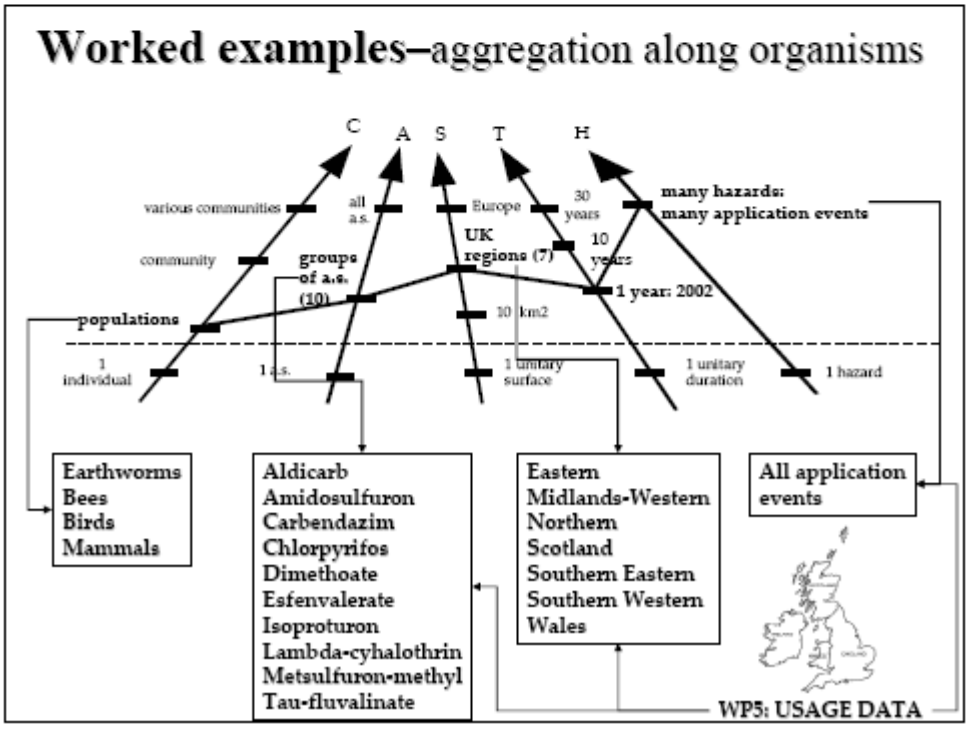
Worked examples - Output of Chronic Risk Earthworm Indicator combined with pesticide usage data: aggregation along time, space, actives

Usage data of Spiroxamine, Triadimenol and Trifluralin on Wheat crops in the UK: 1992-2004

Area for which risk is below screening




Worked examples - Output of Chronic Risk Earthworm Indicator combined with pesticide usage data: aggregation along time, space, actives
Usage data of Spiroxamine, Triadimenol and Trifluralin on Wheat crops in the UK: 1992-2004
Area for which risk is below 0.1
Area for which risk is above 0.1 and below
Area for which risk is above 0.15 and below
Area treated (ha)
1500000.0
1000000.0
500000.0
0.0
1994
1996
1998
2000
2002
2004


Worked examples–aggregation along organisms
C
A
S
T
H
various communities
community
populations
1 individual
all a.s.
groups of a.s. (10)
1 a.s.
Europe
UK regions (7)
10 km2
1 unitary surface
30 years
10 years
1 year: 2002
1 unitary duration
many hazards: many application events
1 hazard
Earthworms
Bees
Birds
Mammals
Aldicarb
Amidosulfuron
Carbendazim
Chlorpyrifos
Dimethoate
Esfenvalerate
Isoproturon
Lambda-cyhalothrin
Metsulfuron-methyl
Tau-fluvalinate
Eastern
Midlands-Western
Northern
Scotland
Southern Eastern
Southern Western
Wales
All application events
WP5: USAGE DATA

Worked examples–aggregation along organisms

Risk for each terrestrial group may differ depending on exposure estimates and assumptions for each risk event

					Earthworms		Bees		Birds		Mammals	
Crop	Region	Active	Month	Area treated	ETR	Score	ETR	Score	ETR	Score	ETR	Score
Wheat winter	Eastern	Chlorpyrifos	jan	373	0.11	1	0	0	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	jan	2,451	0.11	1	0	0	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	Feb	838	0.11	1	2630.6	1	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	Feb	1,545	0.11	1	2630.6	1	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	March	803	0.08	0	2603.4	1	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	March	1,026	0.11	1	2603.4	1	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	June	2,088	0.01	0	12203.4	1	2.007	1	0.055	0
Wheat winter	Eastern	Chlorpyrifos	Oct	103	0.11	1	0	0	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	Oct	221	0.11	1	0	0	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	Nov	36	0.11	1	0	0	2.98	1	0.65	0

Winter wheat	Oct to Feb	Honey bees do not fly

		Crop growth phases	
Crop	Time	Invertebrates	Vertebrates
Winter wheat	Sep to Mid Nov	Stage 1: Bare emergence	Phase 1: early
Winter wheat	Late Nov to Early Apr	Stage 2: Leaf development	Phase 1: early
Winter wheat	Mid Apr to Early June	Stage 3: Stem elongation	Phase 2: late
Winter wheat	Mid June	Stage 4: Flowering	Phase 2: late
Winter wheat	Late June to Mid Aug	Stage 5: Senescence Ripening	Phase 2: late

Worked examples–aggregation along organisms

How do we aggregate different terrestrial groups to obtain an overall risk for the terrestrial compartment?

					Earthworms		Bees		Birds		Mammals	
Crop	Region	Active	Month	Area treated	ETR	Score	ETR	Score	ETR	Score	ETR	Score
Wheat winter	Eastern	Chlorpyrifos	jan	373	0.11	1	0	0	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	jan	2,451	0.11	1	0	0	2.98	1	0.65	0
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Wheat winter	Eastern	Chlorpyrifos	Oct	221	0.11	1	0	0	2.98	1	0.65	0
Wheat winter	Eastern	Chlorpyrifos	Nov	36	0.11	1	0	0	2.98	1	0.65	0

Lack of scientific justification of a specific ranking or weighting for the different terrestrial groups

Further indicators – Canada: Pierre Mineau

Pierre Mineau's indicator for acute avian mortality applicable to **cholinesterase inhibiting** pesticides (Mineau, 2002)

Logistic regression that models the probability of acute avian mortality

Parameters taken into consideration

- •Dermal Toxicity Index (DTI: based on mammalian Dermal Toxicity)
- •Toxic Potential (TP)
  - •Toxicity (HD_5)
  - •Application Rate
- •Physicochemical characteristics of pesticides
  - •Henry's Law Constant (HLC)

Two major outputs

- •Probability (p) of avian mortality
- •Application rate predicted to cause *p* of avian mortality

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  - Toxicity (HD_5)
  - Application Rate
- Physicochemical characteristics of pesticides
  - Henry's Law Constant (HLC)

Two major outputs

- Probability (p) of acute avian mortality $p = \frac{e^{\alpha+b(TP)+c(DTI)+d(HLC)}}{1+e^{\alpha+b(TP)+c(DTI)+d(HLC)}}$
- Application rate predicted to cause p of avian mortality

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  - Henry's Law Constant (HLC)

Two major outputs

- Probability (p) of acute avian mortality
- Application rate predicted to cause p of acute avian mortality

Further indicators – Canada: Pierre Mineau

p	Aldicarb	Chlorpyrifos	Dimethoate
0.1			
0.2			
0.3			
0.4			
0.5			
0.6			
0.7			
0.8			
0.9			

Application rate=HD_5 equivalents*HD_5*10

↕

TP=Log_{10}(HD_5 equivalents)

Further indicators – Canada: Pierre Mineau

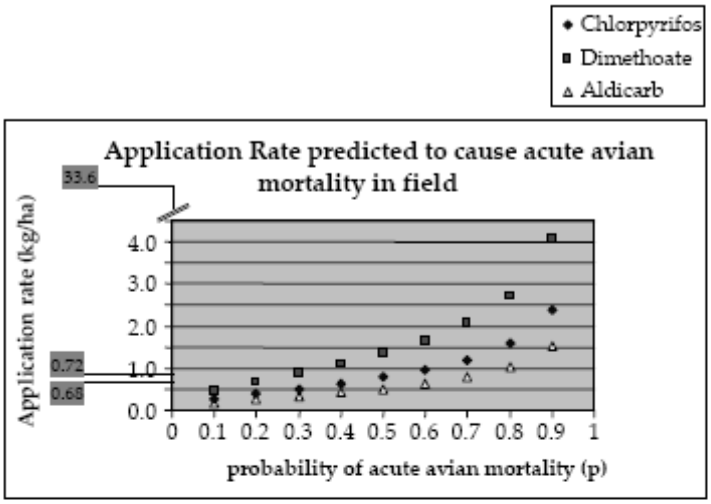
	AR predicted to cause certain acute avian mortality (kg/ha)		
p	Aldicarb	Chlorpyrifos	Dimethoate
0.1	0.1681	0.2598	0.4477
0.2	0.2528	0.3907	0.6733
0.3	0.3316	0.5124	0.8830
0.4	0.4141	0.6400	1.1028
0.5	0.5079	0.7848	1.3524
0.6	0.6228	0.9624	1.6585
0.7	0.7778	1.2020	2.0713
0.8	1.0201	1.5764	2.7166
0.9	1.5341	2.3706	4.0853

Application rate=HD_5 equivalents*HD_5*10

↕

TP=Log_{10}(HD_5 equivalents)

Further indicators – Canada: Pierre Mineau



Further indicators – Canada: Pierre Mineau

Pierre Mineau's indicator for chronic avian mortality (Mineau et al., 2006): focusing on insectivorous 15g bird

Toxicity

- NOEC →NOAEL by taking into account daily dietary input
- GeoMean of two (or more species)
- Uncertainty regarding extrapolating from lab studies is taken into account by implementing acute risk Extrapolation Factors
- Critical Residue concentration (C_t) is calculated by taking into account a 15g insectivorous species

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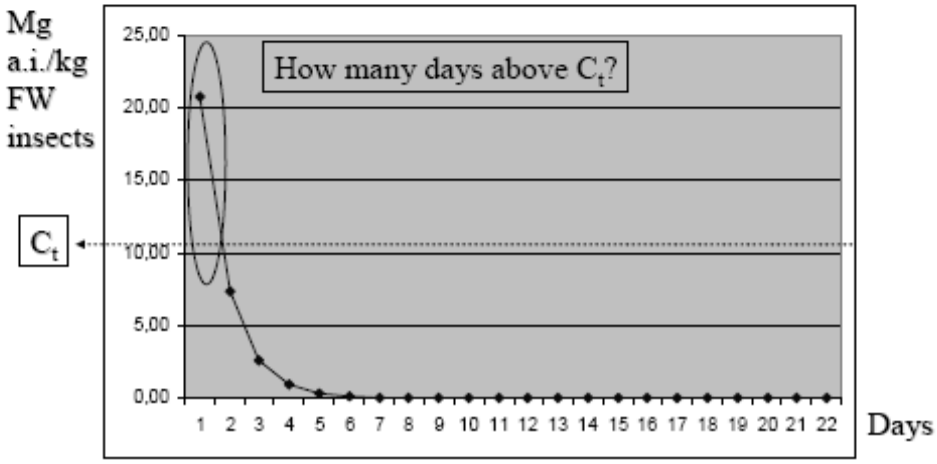
Exposure

- •Initial RUD in insects
- •First rate order degradation, is assumed based on foliar DT_{50}
- •Missing foliar DT_{50} estimated by soil DT_{50}

Further indicators – Canada: Pierre Mineau

Pierre Mineau's indicator for chronic avian mortality (Mineau et al., 2006): focusing on insectivorous 15g bird
Example: a risk event of chlorpyrifos on apples crops



WP6 – conclusions and possible shortfalls

- Design is structured around approved regulatory procedures: facilitates harmonisation within EU; however, validation from field studies is lacking and it needs to be ensured that the "software tool" will be regularly updated according to the most recent EU approved information and/or decisions made
- "Forecasts" of possible risk can be produced based, for example, on certain mitigation measures, withdrawal of certain products, etc.
- Terrestrial organisms may appear "underrepresented", particularly when analysing towards the past, due to lack of toxicity figures
- Outcome for risk indicators of the terrestrial environment would be rather presented as a "set of risk indicators" than an overall figure, as aggregation of different groups of terrestrial organisms is difficult due to diverse exposure estimates

Ton van der Linden | 13-11-2006

HAIR Groundwater Indicators

RIVM HAIR Groundwater Indicator

Sector Milieu en Veiligheid

Contributors to the groundwater indicator

Ton van der Linden, RIVM, NL
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Jos Boesten, Alterra, NL
Marnik Vanclooster, UCL, BE

Contents of presentation

1. Introduction
2. Development of the indicator
3. Discussion
4. Conclusions

Leaching to the groundwater is one of the indicators of pesticide risk

- The leaching of pesticides to the groundwater is often calculated with process-oriented models like GeoPEARL and these can be used at scales ranging from the catchment scale up to the Pan-European scale
- But: the calculation time has to be short when used in pesticide risk indicators
- Therefore: a metamodel is necessary

Requirements of the metamodel

- Fast code
- Input data should be readily available

The metamodel

- A modified attenuation factor model, as described by Van der Zee and Boesten (1991)
- Describes the most important processes, i.e. degradation, sorption, transport and plant-uptake

$$F = \exp\left(-\frac{k(\theta + \rho f_{OC} K_{OC})L + PSL}{q}\right)$$

Redefinition as a regression model

in terms of concentrations

$$\ln C_{FOCUS} = \alpha_0 + \alpha_1 \frac{k\theta L}{q} + \alpha_2 \frac{k\rho f_{OC} K_{OC} L}{q} + \alpha_3 \frac{PSL}{q}$$

Analyses showed that the third term is not relevant

- So, with L=1 m, the model reduces to

$$\ln C_{FOCUS} = \alpha_0 + \alpha_1 \frac{k\theta}{q} + \alpha_2 \frac{k\rho f_{om} K_{om}}{q}$$

- k is the first-order transformation rate coefficient, temperature corrected using the Arrhenius equation (d^{-1})
- ρ is the bulk density of the soil ($kg\ L^{-1}$)
- f_{om} is the organic matter content ($kg\ kg^{-1}$)
- K_{om} is the organic matter/water distribution coefficient ($L\ kg^{-1}$)
- q is the volume flux of water ($m\ d^{-1}$)
- θ is the soil water content ($m^3\ m^{-3}$)

Derivation of the regression parameters

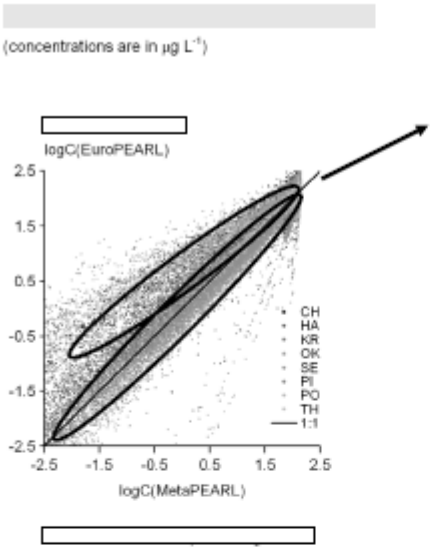
- to obtain the regression parameters ($\alpha_0 \ldots \alpha_2$), databases were constructed with GeoPEARL

- the dependent variable: leaching concentration (C_{FOCUS})
- the independent variables (see previous slide) were calculated with data, which are available in the EuroPEARL database
- soil properties (f_{om} and ρ) are averaged over the top 1 m, q and θ are averaged over 20 years
- the regression was carried out with robust regression

Comparison of the metamodel and EuroPEARL

- The leaching concentration is calculated with the metamodel and with EuroPEARL
- The metamodel is parameterised with the same data as EuroPEARL to avoid possible differences in Pan-European datasets
- The comparison is therefore limited to data available in the SPADE database

Comparison of the metamodel and EuroPEARL (2)



Majority of data point is in a relatively small range around the 1:1 line

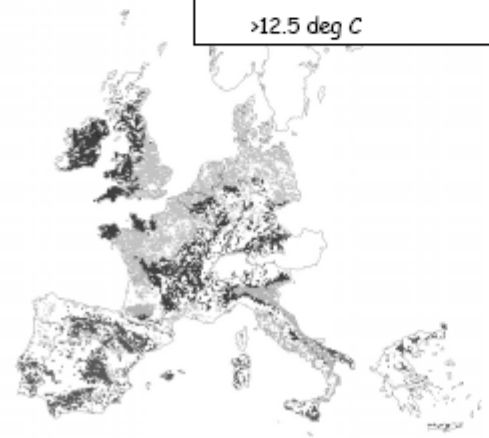
Separate fittings were therefore carried out for four climate zones, based on mean annual temperature and rainfall

Climate zones were based on FOCUS climate zones

Climate zone

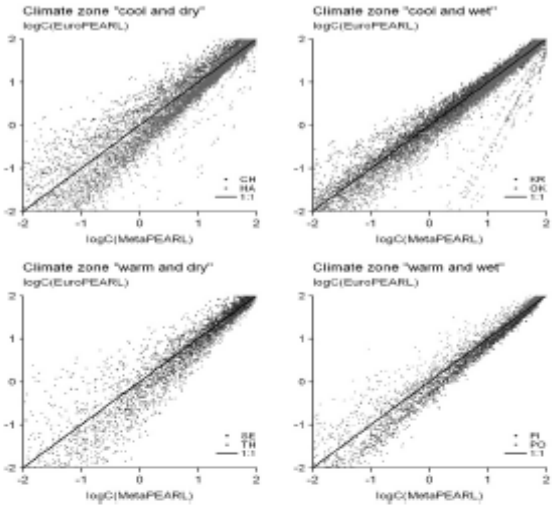
- Cool and wet
- Cool and dry
- Warm and wet
- Warm and dry

Annual temperature	Annual precipitation
<12.5 deg C	<800 mm/year
<12.5 deg C	>800 mm/year
>12.5 deg C	<800 mm/year
>12.5 deg C	>800 mm/year

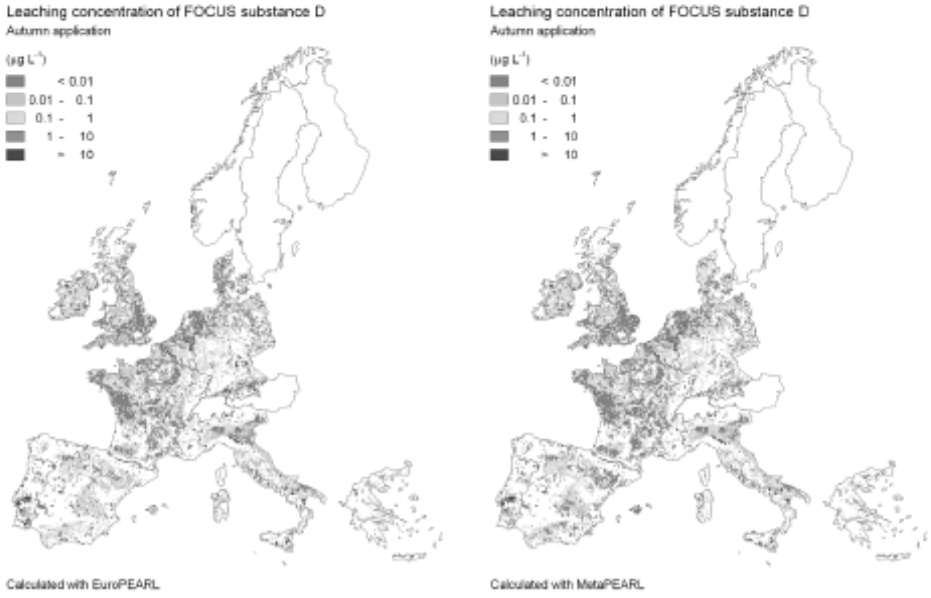


Fitting for separate climate zones is better

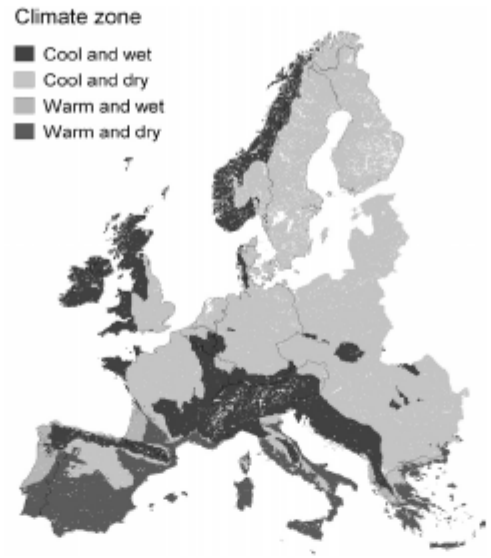
(concentrations are in μg L^{-1})



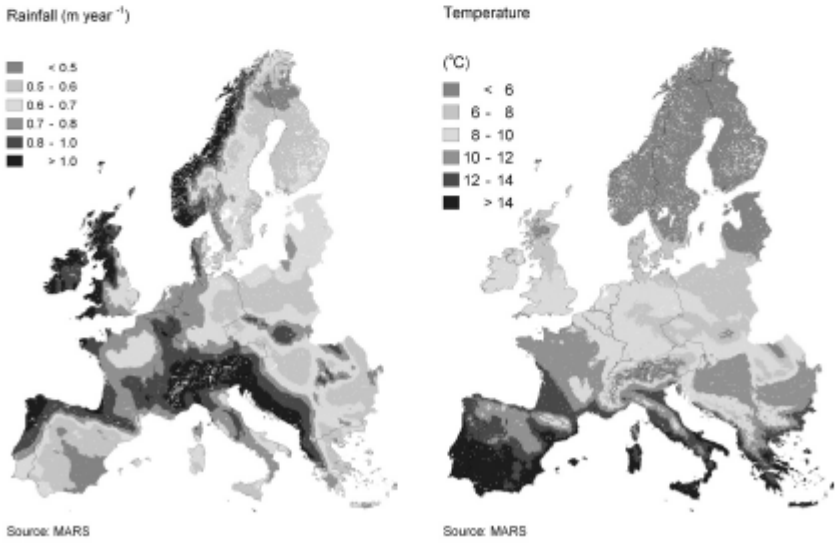
Example



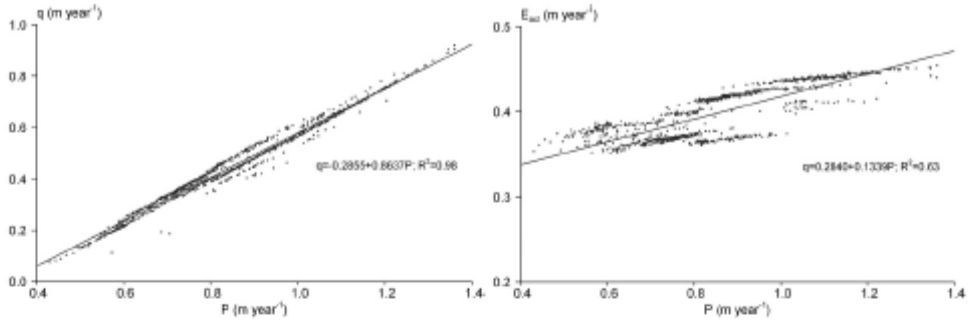
Combination of climatic maps gives the climate zones



Average temperature (T) and rainfall (P) are obtained from the MARS database

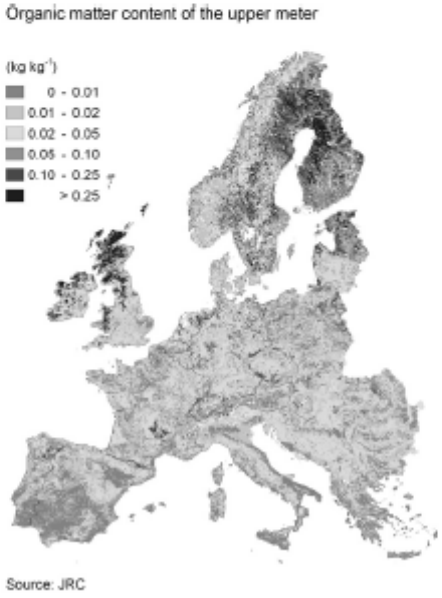


Precipitation surplus (q) is calculated from rain (P)



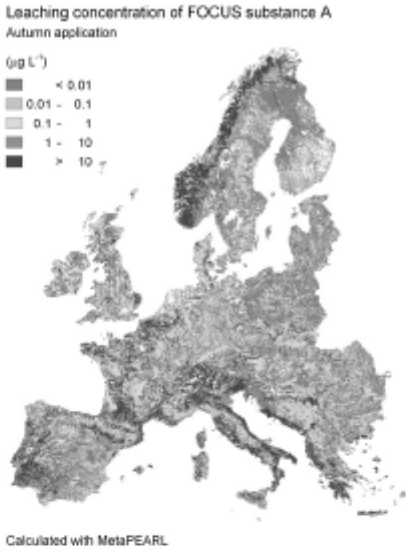
- Confirms earlier findings by Roberts et al. (1980)
- Reason: actual transpiration shows a limited variation throughout Europe (350-450 mm year^{-1})

Organic matter content of the upper meter

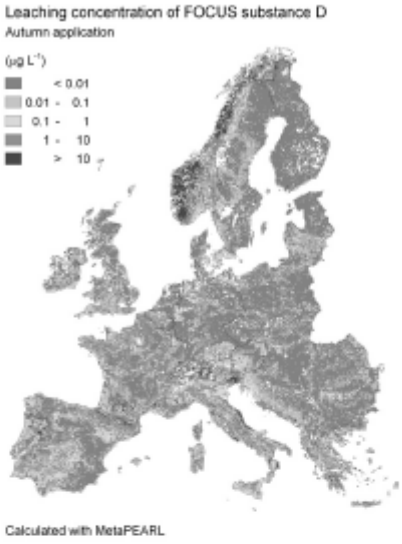


- JRC has a map of organic carbon in the topsoil (0-30 cm) available
- organic carbon is converted to organic matter (OM=1.72xOC)
- data from SPADE-profiles have been used to convert OM_{0-30} values to OM_{0-100} values

Application of MetaPEARL to substance A and D



DT_{50}=60, K_{om}=60



DT_{50}=20, K_{om}=35

Discussion

- Refinement is possible:
  - Other target leaching percentages, 5 – 95%
  - Higher temporal resolution, dependent on application time
  - Higher spatial resolution, catchment - Europe

Higher spatial resolution

For the catchment or the regional scale sometimes more detailed information is available and this can improve the metamodel

- GeoPEARL can be run at higher resolution
- Less pedotransfer functions are necessary when for instance information on groundwater recharge and soil bulk density is available from databases

Conclusions

- Metamodels have been created, using a combination of statistics and an analytical model
- The metamodels give leaching in terms of leaching quantities and leaching concentrations
- The metamodel explains 94% of the total variance of the original model at the European level
- The metamodel uses limited data (P, T, organic matter and texture) and pedotransfer functions
- The metamodel takes into account the most important substance properties, available in standard dossiers (K_{om} and DT_{50})

WP 9
Consumers Indicator

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Antonio Finizio
Dept of Env. Sci, University of Milano Bicocca
Emilio Benfenati, Chiara Porcelli
Istituto di Ricerche Farmacologiche "Mario Negri"
Giovanna Azimonti, Sara Visentin, Domenica Auteri
International Centre for Pesticides and Health Risk Prevention

HAIR (SSPE-CT-2003-501997) HArmonised environmental Indicators for pesticide Risk
Specific targeted research or innovation project of the EU

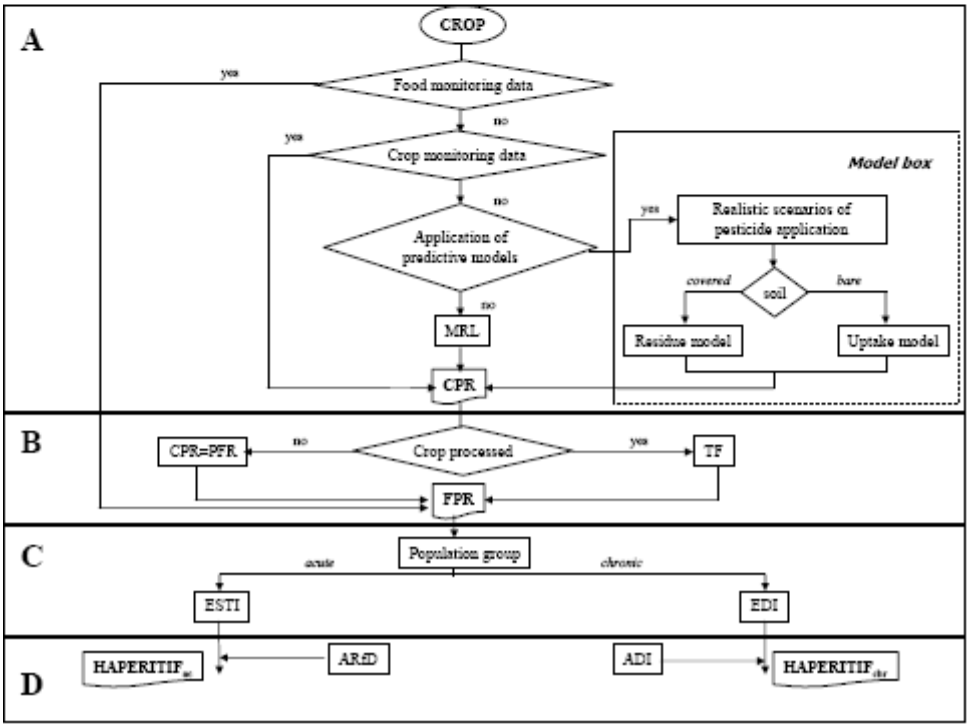
Objective

To develop an indicator (HAPERITIF: Harmonised Pesticide Risk Trend Indicator for Food) that should provide

- information at different scales (from farmers to risk managers) about the quality of different management decisions regarding the risk trend of PPPs on consumers.
- the time trend risk for consumers associated to the consumption of food.
- information on how a pest control strategy, adopted at farm level, or a new agro-environmental policies at national level, are reducing the pesticide exposure for consumer by improving food quality and safety.

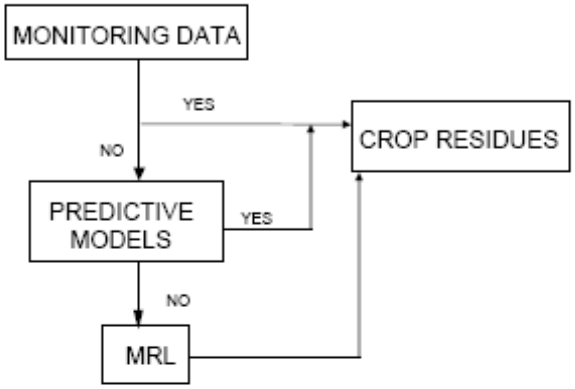
HAPERITIF follows a stepwise approach:

- quantification of pesticide residues on crops
- quantification of pesticide residues on foods (if reliable)
- determination of the exposure (intake)
- calculation of the ratio between the exposure and the toxicological endpoint



Step 1A- Quantification of pesticide residues on a particular crop

Hierarchical approach (decision tree)



Step1A- Monitoring data

Monitoring data on primary crops should be considered as the most realistic situation → they should be preferred for the application of the indicator

PROBLEMS:

- Monitoring data implies quality of analytical data
- Monitoring data are not homogeneously available in EU
- Not all the a.i. potentially present as crop residues, are determined during monitoring campaigns

Positive aspect: Realistic scenario

Negative aspect: Data availability, absence of clear values (> or < LOD, MRL), aggregation

HAPERITIF approach: reconstruction of missing data

Step1A- Predictive Models

- Hundreds of different plant species forming the heterogeneous group of food crops. Variety differences can also account for large differences
- Different plant parts are consumed: roots, tubers, fruit, leaves
- Crops differ in pesticide exposure (uptake from soil or from aerial deposition)

Positive factor:	**Negative Aspects**: Many variable need
Predictive approach	to be modelled for a realistic prediction

HAPERITIF approach: PARDIS model for covered soil and uptake model for bare soil

Step1A- Maximum Residue Level

Maximum Residue Level (MRL) should be used when monitoring data and models could not be used

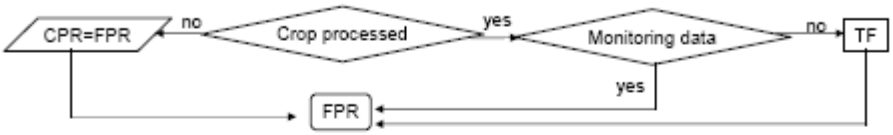
MRL: maximum concentration of pesticide residue

(mg/kg) likely to occur in/on food and feeding stuffs

after the use of pesticides according to GAP.

MRLs generally set at a value derived from field trials. MRLs are generally available for all pesticides registered on a specific crop.

Step 2B- Quantification of pesticide residues on food



CPR=Crop Pesticide Residue, TF=Transformation Factor or % of residues lost or concentrated during the transformation process, FPR=Food Pesticide Residue

When the crop is not further processed: CPR = FPR

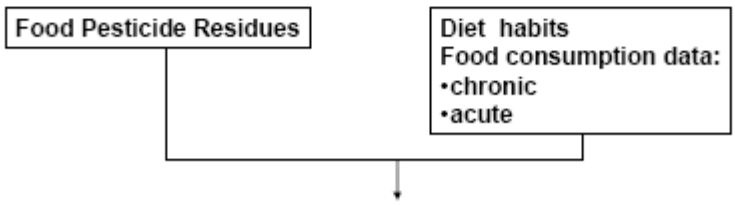
When the crop is processed: FPR = CPR*TF

PROBLEM: transformation factors are scarcely available

HAPERITIF approach: worst case scenario TF=1

Step 3C- Determination of the exposure

Integration of food consumption and chemical concentration for the estimation of exposure



ESTI (Estimated Short Term Intake)

EDI (Estimated Daily Intake)

Use of Food consumption tables for the application of the indicator

Available consumption data

- WHO/GEMS Food EU Regional Diet
- PSD Data Requirements Handbook
- National dietary surveys

At present no harmonization of dietary intake tables produced across European countries

HAPERITIF approach: EFCOSUM and EPIC projects.

To define a method for monitoring food consumption in nationally representative samples of all age-sex categories in Europe in a comparable way. To indicate how to make existing food consumption data comparable and available to the health monitoring system (HIEMS).

Step 4D- Calculation of HAPERITIF

The indicator can be applied both to evaluate the acute (HAPERITIFac.) or the chronic (HAPERITIFchr.) risk associated to the consumption of one commodity (crop) or to a particular typology of diet

One a.i. residue in a single commodity
Several a.i. residues in a single commodity
One a.i. residue in several commodities
Several a.i. residues in several commodities

One a.i. residue in a single commodity

The simplest level of aggregation is through the calculation of an Exposure/Toxicological Ratio

$HAPERITIF_{acute} = ESTI/ARfD$
$HAPERITIF_{chr} = EDI/ADI$

To compare the risk of different a.i. residues present in a particular commodity
To identify the most hazardous substances to consumer health

The generic exposure will be indicated as EXP in all the equations representing aggregation. The toxicological endpoint will be generically indicated with *TOX*.
The exposure can be considered generically calculated, disregarding acute or chronic intake, as follows:

$$EXP = Ra.i. \times \frac{I}{B_w}$$

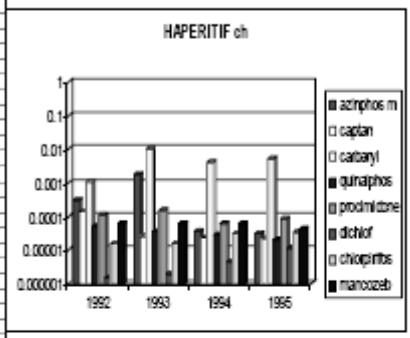
where:
$R_{a.i.}$ = residue of the a.i. (mg/kg)
I= intake of a crop (kg)
B_w = body weight (kg)

Comparison of the risk for all a.i. residues and identification of the one that should be lowered to improve pear quality in Northern Italy

$$HAPERITIF_{chr} = EDI/ADI$$

year	chemical	I	EDI	HAPERITIF CHR
1992	AZINPHOS	0.035	1.562E-06	3.163E-04
1992	CAPTAN	0.305	1.390E-05	1.390E-04
1992	CARBARYL	0.018	8.109E-07	1.081E-03
1992	QUINALPHOS	0.010	4.715E-07	5.238E-05
1992	PROCY	0.061	2.784E-06	1.113E-04
1992	diclofluanid	0.010	4.647E-07	1.549E-06
1992	mancozeb	0.071	3.236E-06	8.489E-05
1992	clorp	0.004	1.626E-07	1.626E-05
1993	AZINPHOS	0.194	8.049E-06	1.770E-03
1993	CAPTAN	0.061	2.772E-06	2.772E-05
1993	PROCY	0.087	3.963E-06	1.585E-04
1993	QUINALPHOS	0.008	3.481E-07	3.867E-05
1993	CARBARYL	0.170	7.742E-06	1.032E-02
1993	DICHLOF	0.013	5.077E-07	1.958E-06
1993	chlorpirifos	0.004	1.626E-07	1.626E-05
1993	mancozeb	0.071	3.236E-06	8.489E-05
1994	CAPTAN	0.054	2.474E-06	2.474E-05
1994	CARBARYL	0.070	3.200E-06	4.267E-03
1994	CHLORPYR	0.007	3.153E-07	3.153E-05
1994	AZINPHOS	0.004	1.827E-07	3.654E-05
1994	QUINALPHOS	0.006	2.600E-07	2.907E-05
1994	DICHLOF	0.029	1.343E-06	4.477E-06
1994	PROCY	0.034	1.544E-06	6.178E-05
1994	Mancozeb	0.071	3.236E-06	8.489E-05
1995	CARBARYL	0.088	3.988E-06	5.318E-03
1995	DICHLOF	0.075	3.421E-06	1.140E-05
1995	CHLORPYR	0.008	3.524E-07	3.524E-05
1995	PROCY	0.048	2.188E-06	8.754E-05
1995	Azinp	0.004	1.823E-07	3.267E-05
1995	captan	0.051	2.319E-06	2.319E-05
1995	Mancozeb	0.050	2.270E-06	4.668E-05
1995	Quinalphos	0.004	1.822E-07	2.025E-05

Pear monitoring data - IT



Several a.i. residues in a single commodity

Multi residues exposure of consumers as consequence of their simultaneous presence in a given commodity

$$HAPERITIF_{(ac\ or\ chr.)} = \sum_{1=a.i.}^{n} \frac{EXP_{a.i.}}{TOX_{a.i.}}$$

EXP = Estimated Intake (Acute or Chronic)
TOX = ARfD or ADI

HAPERITIF approach: model of concentration addition (CA), applicable to chemicals with the same toxicological mode of action.
Problem: tends to overestimate the mixture toxicity of dissimilarly acting substances

To monitor the time trend risk associated to food consumption of a particular crop, the calculation is repeated for several years and the first one acts as a benchmark against which the success of new strategies can be evaluated.

The indicator can be computed for a particular country, region, or territory, or at EU level.

One a.i. residues in several commodity

Higher levels of exposure in the consumer's diet due the presence of the compound residues in different commodities

$$\text{HAPERITIF}_{(\text{chr.})} = \sum_{crop=1}^{n} \frac{EXP_{crop,a.i.}}{TOX_{a.i.}}$$

EXP = Estimated Intake (Chronic)
TOX = ADI

The indicator provides information about the risk for consumers associated to a particular a.i. in a given diet

Several a.i. residues in several commodities

Trend analysis system for calculating the risk for different categories of consumers who are associated to a particular diet

$$HAPERITIF = \sum_{crop,a.i=1}^{n} \frac{EXP_{crop,a.i.}}{TOX_{a.i}}$$

EXP = Estimated Intake (Acute or Chronic)
TOX = ARfD or ADI

Problems to solve:

- Availability of monitoring data and missing data
- Availability of toxicological end point
- Availability of transformation factor (TF)
- Data sets on dietary intake at the country level are not directly comparable at the European level
- There is no European food composition database available yet
- EPIC data base is in progress

Conclusion

Depending on the level of aggregation the indicator will provide information useful for:

- establishing an appropriate risk management of plant protection products for human health;
- assessing the results of new and existing agro-environmental policies on the quality of crop production;
- evaluating the quality of crop production among different EU countries.

RRSG-HAIR Joint Seminar on
Harmonised Environmental Indicators for Pesticide Risk
OECD Working Group on Pesticides / EU HAIR Steering Committee

Occupational Indicators for Pesticide Risk (WP 10)

Ghent University (coordination)
Steurbaut, W. & Garreyn, F.

Veterinary and Agrochemical Research Centre
Piñeros-Garcet, J.D., Van Bol, V. & Pussemier, L.

International Centre for Pesticides and Health Risk Prevention
Visentin, S. & Tiramani, M.

Introduction

- WP 10 Development of indicators for human health for exposure during & after application:

  Applicator
  Farm worker
  Bystander & Resident
  Sensitive population groups (children, pregnant women,…)

- Estimating risk using **risk indices**

  Risk index (RI) = $\frac{\text{estimated human exposure}}{\text{toxicological endpoint}}$

1

Introduction
Applicator
Re-Entry worker
Bystander & Resident
Sensitive population groups
Combined Risk Assessment

Applicator Indicator

Acute

- $RI_{op,acute} = \frac{IE_{op,acute}}{AOEL} = \frac{\left[\frac{IE_{operator} * AR * Area_{treated}}{BW}\right]}{AOEL}$
- $IE_{operator} = IE_{mix/load} + IE_{app}$
  - $IE_{mix/load} = (L_i * PPE_i * Ab_i) + (L_{hand} * PPE_{hand} * Ab_D)$
  - $IE_{app} = (L_i * PPE_i * Ab_i) + (L_{hand} * PPE_{hand} * Ab_D) + (L_{body} * PPE_{body} * Ab_D)$

$RI_{op\ acute}$: acute operator Risk Index
$IE_{op,\ acute}$: acute Internal Exposure operator (mg/kg bw/d)
AOEL: Acceptable Operator Exposure Level (mg/kg bw/d)
$Area_{treated}$ (ha/d)
BW: body weight (default: 70 kg)
AR: application rate (kg a.s./ha)
PPE_i, PPE_{hand}, PPE_{body}: Personal Protective Equipment Coefficients
L_i, L_{hand}, L_{body} (mg/kg a.s.) < EUROPOEM
Ab_i, Ab_D: inhalation/dermal absorption factor (-)

Introduction
Applicator
Re-Entry worker
Bystander & Resident
Sensitive population groups
Combined Risk Assessment

Applicator Indicator

Chronic

- $RI_{op,chronic} = \frac{IE_{op,chronic}}{AOEL} = \frac{IE_{op,acute} * \frac{N_{events}}{AT}}{AOEL}$

$RI_{op,chronic}$: chronic operator Risk Index
$IE_{op,chronic}$: chronic Internal Exposure operator (mg/kg bw/d)
$IE_{op,acute}$: acute Internal Exposure operator (mg/kg bw/d)
AOEL: Acceptable Operator Exposure Level (mg/kg bw/d)
N_{events}: Number of exposure events (equal the frequency of application)
AT: averaging time (e.g. 365 days for year averaged exposure)

Introduction
Applicator
Re-Entry worker
Bystander & Resident
Sensitive population groups
Combined Risk Assessment

Re-Entry worker Indicator — Acute

- DE: dermal exposure (mg/person/day): **foliage**

$$DE = 0{,}001 * DFR * TF * T * P$$

0.001: conversion factor for the units (-)
DFR: dislodgeable foliar residues (µg/cm² per kg applied/ha)
TF: transfer factor (cm²/person/d)
T: duration of re-entry (hr/d)
P: factor for PPE (with PPE: 0.1, no PPE: 1) (-)

- Declination pesticide residues
  - exponential: $DFR_t = e^{(\alpha - \beta t)}$; $\ln(DFR_0) = \alpha$ (R^2>0,85); $\beta = -\frac{\log(0,5)}{T_{1/2}}$
  - logarithmic: $\log(DFR_t) = \alpha - \beta * [\log(t)]$
  - ~ climatic factors (humidity, temperature,…), physico-chemical properties

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Combined Risk Assessment

Re-Entry worker Indicator — Acute

- DE: dermal exposure (mg/person/day): **soil**
  - dermal adherence concept
  - minor contribution
- Algorithm: EUROPOEM II Re-Entry Working Group

$$DE = \frac{Conc_S * DA_S * SA_C * T_{S/Sk}}{\rho_{soil}}$$

$Conc_S$: active substance soil concentration (mg/m³)
DA_S: dermal adherence of soil (mg/cm²) (default: 0,44 mg/cm²)
SA_C: contaminated skin area (cm²) (default: 820 cm²)
ρ_{soil} : soil bulk density (g/cm³)
$T_{S/Sk}$: transfer from soil to skin (-)

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Re-Entry worker Indicator — Acute

- I: inhalation exposure (mg/person/day): **greenhouse**

$$I = AR * TSF * T$$

I: potential inhalation exposure (mg a.s./d inhaled)
AR: application rate (kg a.s./ha)
T: duration of re-entry (hr/d)
TSF: task specific factor

Scenario	Re-entry time	TSF
Cutting ornamentals	-	0,1
Sorting & bundling ornamentals	-	0,01
Re-enter LV mist application	8	0,03
Re-enter roof fogger	16	0,15

- I: inhalation exposure (mg/day): **dust**

⇒ Typically very low risk: route not considered

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Re-Entry worker Indicator — Chronic

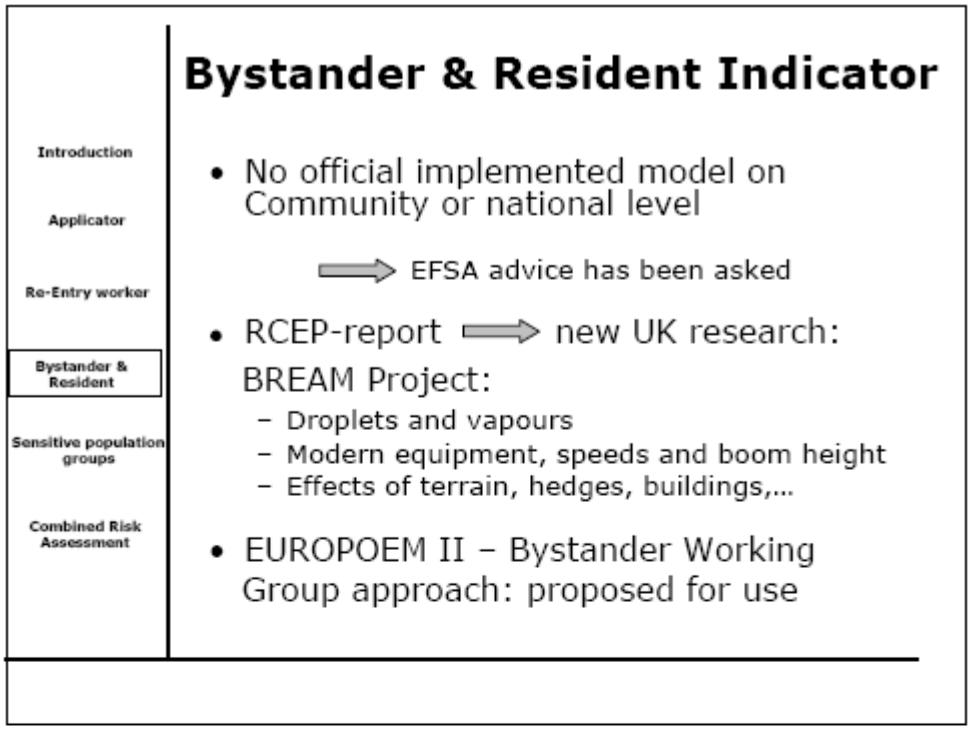
- DE: dermal exposure (mg/person/day):

$$DE_{chronic} = DE_{acute} * \frac{N_{events}}{AT} = DE_{acute} * \frac{WD}{AT}$$

- I: Inhalation exposure (mg/person/day)

$$I_{chronic} = I_{acute} * \frac{N_{events}}{AT} = I_{acute} * \frac{WD}{AT}$$

$DE_{chronic}$: chronic dermal exposure (mg/d)
DE_{acute}: acute dermal exposure (mg/d)
$I_{chronic}$: chronic inhalation exposure (mg/person/day)
I_{acute}: chronic inhalation exposure (mg/person/day)
N_{events}: Number of exposure events
WD: estimated number of workdays (d) (expert judgment)
AT: averaging time (d); yearly averaged chronic dose: AT = 365


Bystander & Resident Indicator
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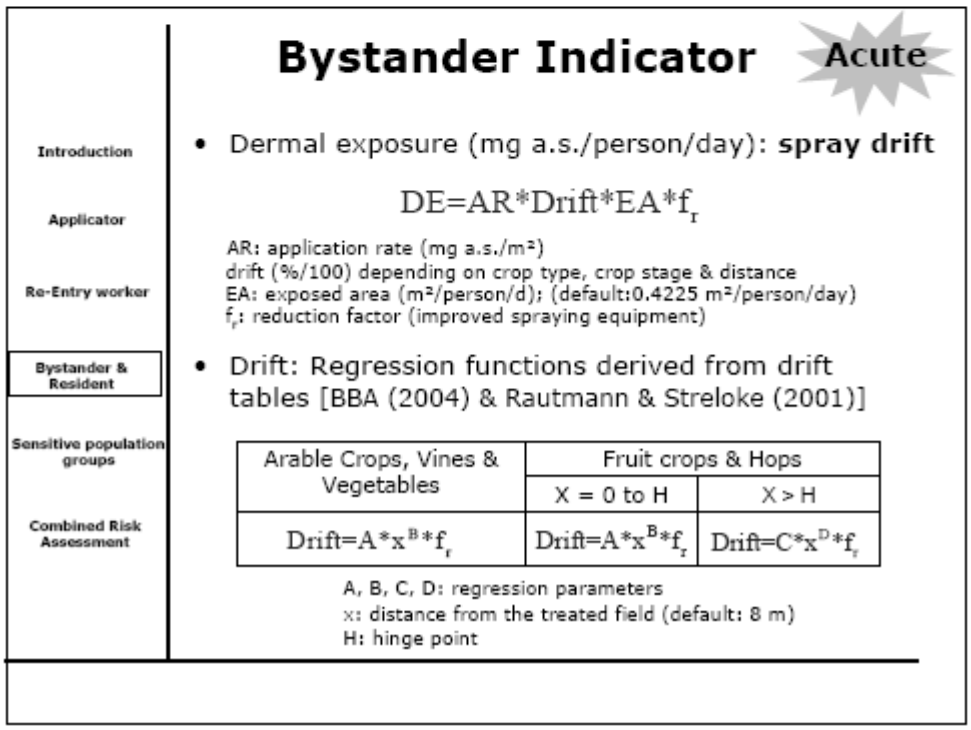
Combined Risk Assessment
• No official implemented model on Community or national level
⇒ EFSA advice has been asked
• RCEP-report ⇒ new UK research: BREAM Project:
– Droplets and vapours
– Modern equipment, speeds and boom height
– Effects of terrain, hedges, buildings,…
• EUROPOEM II – Bystander Working Group approach: proposed for use


Bystander Indicator
Acute
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• Dermal exposure (mg a.s./person/day): spray drift
DE=AR*Drift*EA*f_r
AR: application rate (mg a.s./m²)
drift (%/100) depending on crop type, crop stage & distance
EA: exposed area (m²/person/d); (default:0.4225 m²/person/day)
f_r: reduction factor (improved spraying equipment)
• Drift: Regression functions derived from drift tables [BBA (2004) & Rautmann & Streloke (2001)]
Arable Crops, Vines & Vegetables
Fruit crops & Hops
X = 0 to H
X > H
Drift=A*x^B*f_r
Drift=A*x^B*f_r
Drift=C*x^D*f_r
A, B, C, D: regression parameters
x: distance from the treated field (default: 8 m)
H: hinge point

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Bystander Indicator

Acute

- I: Inhalation exposure (mg a.s./person/day)
  - **EUROPOEM II approach**

$$I = C_{inhaled} * IR * T \qquad C_{inhaled} = Default * C_{spray}$$

Def.: Arable sprayers = 0.03 ml spray/m³ breathed air
Def.: Orchards sprayers = 0.06 ml spray/m³ breathed air
$C_{inhaled}$: a.s. conc. in breathing zone (mg a.s./m³)
C_{spray}: a.s. conc. in spray solution (mg a.s./ml)
IR: inhalation rate (m³/hr)
T: duration of exposure (hr/d)

  - **Based on operator inhalation**

$$I = \frac{I_a * WR * AR}{(WR * ST)}$$

I_a: applicator respiratory exposure (mg/kg a.s.)
AR: application rate (kg a.s./ha)
WR: work rate (ha/dag)
ST: spraying time (min/ha); exposure during 1 min

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Bystander Indicator

Acute

- Total exposure (mg a.s./person/day) and risk index

$$IE_{bystander} = \frac{DE * Ab_D + I * Ab_I}{BW} \qquad RI_{bystander} = \frac{IE_{bystander}}{AOEL}$$

DE: dermal exposure (mg a.s./person/d))
I: respiratory exposure (mg a.s./person/d)
Ab_D: dermal absorption factor
Ab_I: inhalation absorption factor
BW: body weight (default: 70 kg)
$AOEL_{adapted}$: Acceptable Operator Exposure Level (mg/kg bw/d)

- Toxicity Parameter: AOEL (mg a.s./person/day)
  - Aim to protect in the worst case: favour continued use
  - Current research might imply setting of new toxicity endpoints (EFSA, 2006)

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Resident Indicator

Chronic

- Dermal exposure (mg a.s./person/day)

$$DE_{chronic} = DE_{acute} * \frac{N_{events}}{AT} = DE_{acute} * \frac{RD}{AT}$$

- Inhalation exposure (mg a.s./person/day)

$$I_{chronic} = C_{air} * IR * 10^3 * DED * \frac{RD}{AT}$$

$DE_{chronic}$: chronic resident dermal exposure (mg/person/day)
DE_{acute}: acute resident dermal exposure (mg/person/day)
$I_{chronic}$: chronic resident inhalation exposure (mg/person/day)
C_{air}: TWA concentration of the pesticide in the air (g a.s./m³)
IR: inhalation rate (m³ air/hr) (default: 0,82 m³/hr)
DED: daily exposure duration (hr/d)
N_{events}: number of exposure events (-)
RD: resident days (d)
AT: averaging time (d); yearly averaged chronic dose: AT = 365 d

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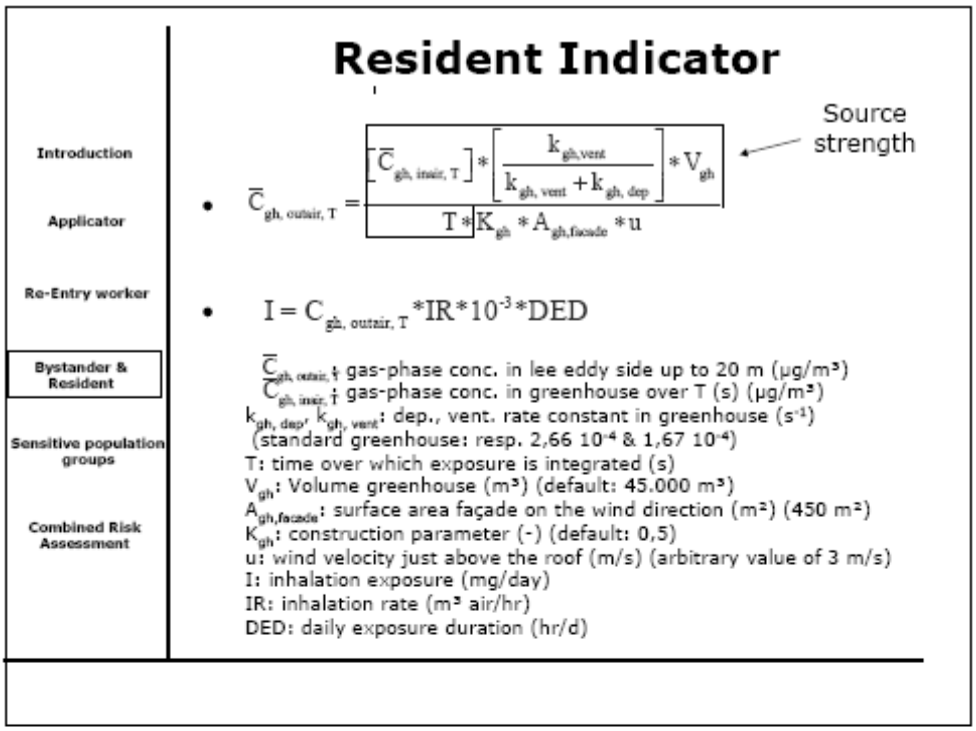
Resident Indicator

- Exposure assessment of residents nearby greenhouses: (Scientific tool developed for USES)
  - Calculation up to a distance of 20 m
  - Calculation scheme: process oriented in stead of use of emission factors
  - Relevant processes: volatilisation, deposition & outdoor ventilation of remaining residues
  - Only inhalation exposure, dermal negligible
- Validation:
  - Realistic worst case for highly volatile substances
  - Overestimation for less volatile substances

⇨ **Experimental research is needed!**


Resident Indicator
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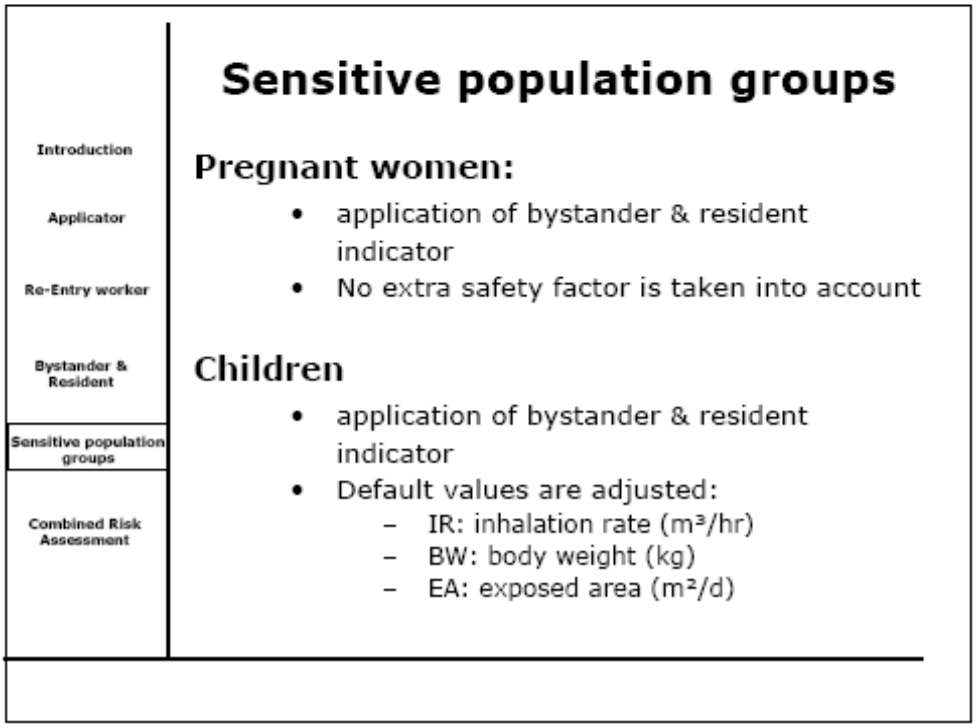
Source strength
$\bar{C}_{gh,outair,T} = \frac{\left[\bar{C}_{gh,inair,T}\right] * \left[\frac{k_{gh,vent}}{k_{gh,vent} + k_{gh,dep}}\right] * V_{gh}}{T * K_{gh} * A_{gh,facade} * u}$
$I = C_{gh,outair,T} * IR * 10^{-3} * DED$
$\bar{C}_{gh,outair,T}$: gas-phase conc. in lee eddy side up to 20 m (µg/m³)
$\bar{C}_{gh,inair,T}$: gas-phase conc. in greenhouse over T (s) (µg/m³)
$k_{gh,dep}$, $k_{gh,vent}$: dep., vent. rate constant in greenhouse (s^{-1})
(standard greenhouse: resp. 2,66 10^{-4} & 1,67 10^{-4})
T: time over which exposure is integrated (s)
V_{gh}: Volume greenhouse (m³) (default: 45.000 m³)
$A_{gh,facade}$: surface area façade on the wind direction (m²) (450 m²)
K_{gh}: construction parameter (-) (default: 0,5)
u: wind velocity just above the roof (m/s) (arbitrary value of 3 m/s)
I: inhalation exposure (mg/day)
IR: inhalation rate (m³ air/hr)
DED: daily exposure duration (hr/d)


Sensitive population groups
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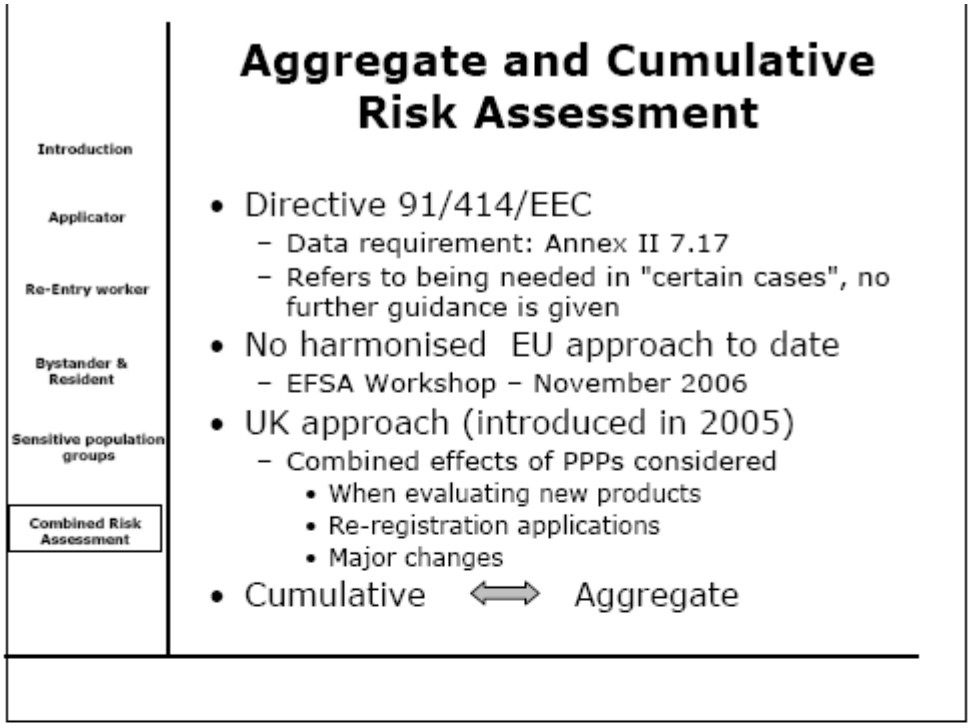
Pregnant women:
application of bystander & resident indicator
No extra safety factor is taken into account
Children
application of bystander & resident indicator
Default values are adjusted:
IR: inhalation rate (m³/hr)
BW: body weight (kg)
EA: exposed area (m²/d)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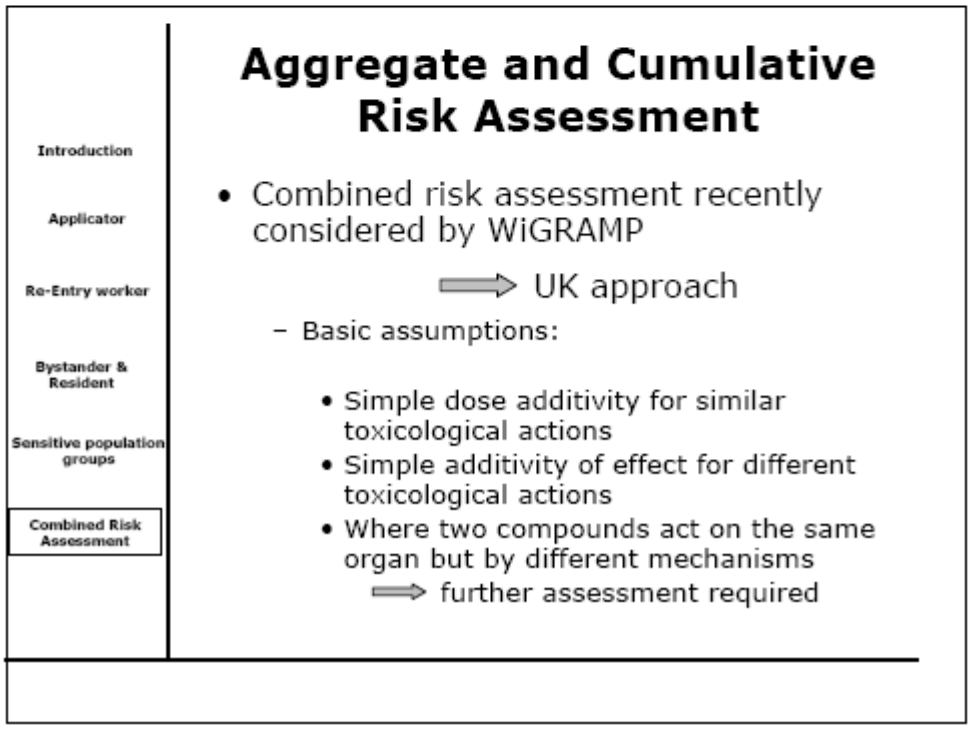
Aggregate and Cumulative Risk Assessment
• Directive 91/414/EEC
– Data requirement: Annex II 7.17
– Refers to being needed in "certain cases", no further guidance is given
• No harmonised EU approach to date
– EFSA Workshop – November 2006
• UK approach (introduced in 2005)
– Combined effects of PPPs considered
• When evaluating new products
• Re-registration applications
• Major changes
• Cumulative ⟺ Aggregate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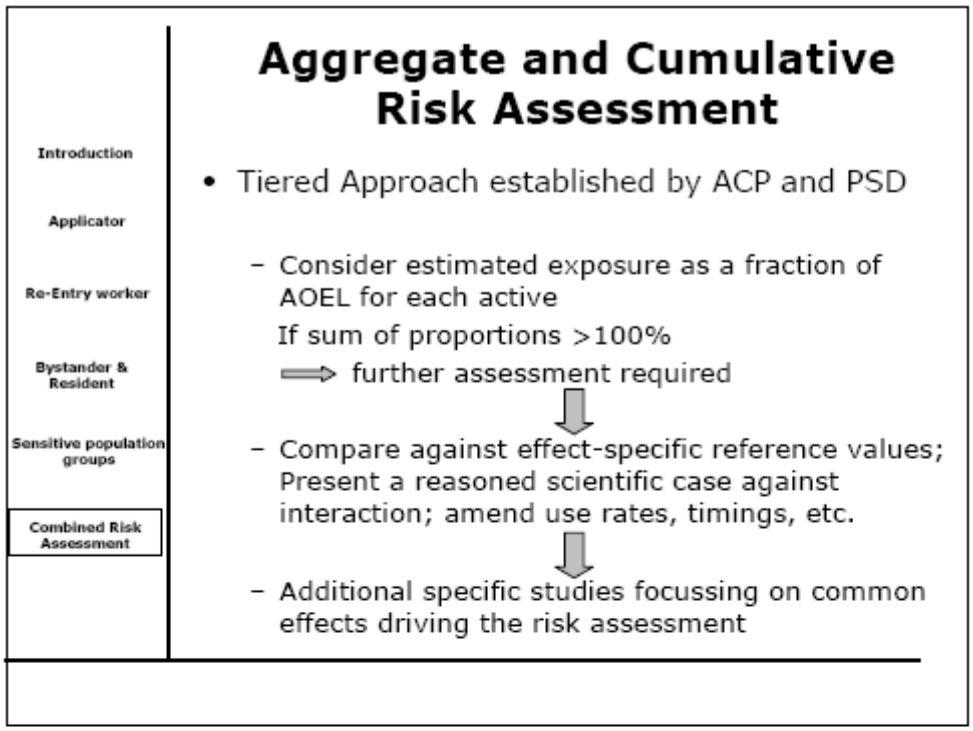
Aggregate and Cumulative Risk Assessment
• Combined risk assessment recently considered by WiGRAMP
⟹ UK approach
– Basic assumptions:
• Simple dose additivity for similar toxicological actions
• Simple additivity of effect for different toxicological actions
• Where two compounds act on the same organ but by different mechanisms
⟹ further assessment required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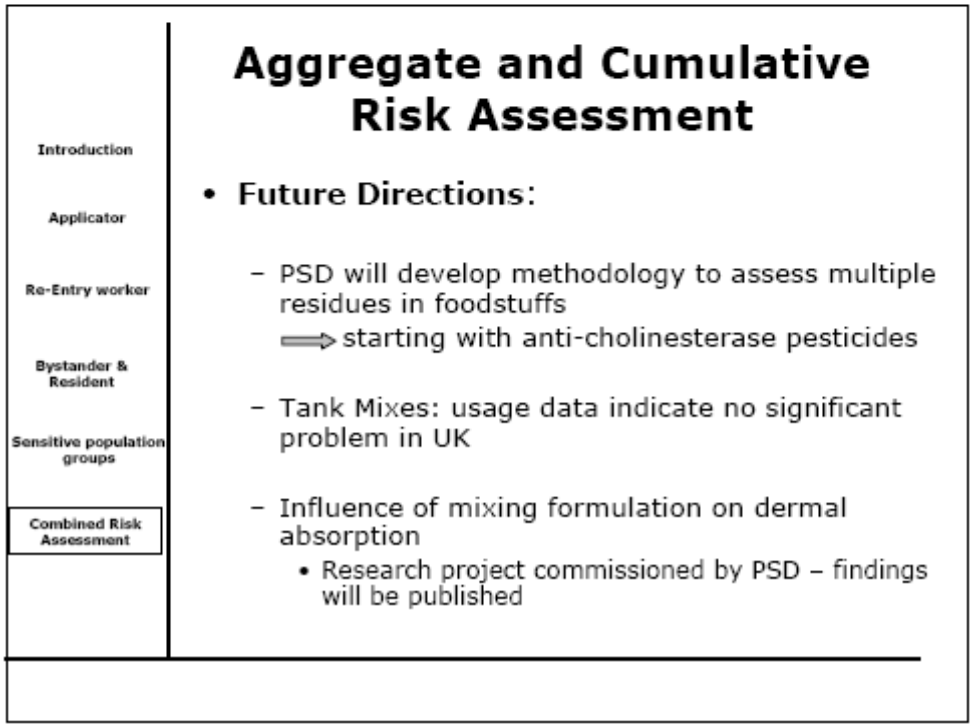
Aggregate and Cumulative Risk Assessment
• Tiered Approach established by ACP and PSD
– Consider estimated exposure as a fraction of AOEL for each active
If sum of proportions >100%
⟹ further assessment required
– Compare against effect-specific reference values; Present a reasoned scientific case against interaction; amend use rates, timings, etc.
– Additional specific studies focussing on common effects driving the risk assessment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• Future Directions:
– PSD will develop methodology to assess multiple residues in foodstuffs
⟹ starting with anti-cholinesterase pesticides
– Tank Mixes: usage data indicate no significant problem in UK
– Influence of mixing formulation on dermal absorption
• Research project commissioned by PSD – findings will be published

Sørensen et al. 2006

Validation of indicators HAIR WP13

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Jørgen Axelsen

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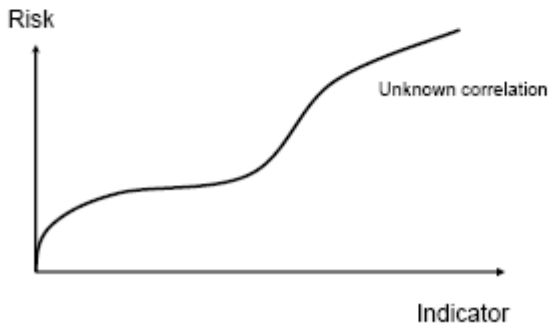
Silkeborg, Denmark

Sørensen et al. 2006

A risk indicator is a assumed correlation between the known indicator and the unknown risk



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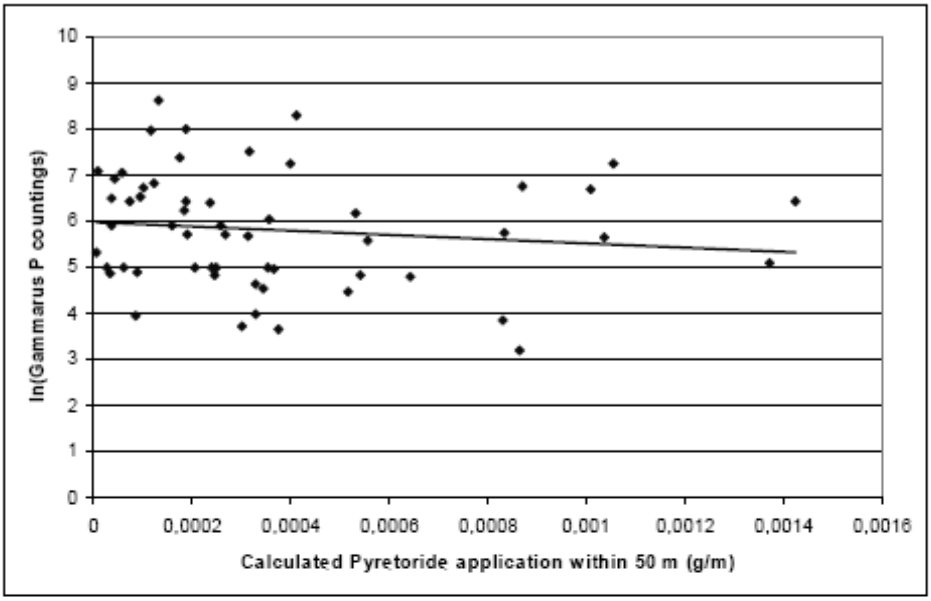
Real validation is difficult !!



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Validation of exposure related to emission using monitoring data

		Predicted variables *Set 1*		Predicting variables *Set 2*	
Id	Substances	*DetFreq* (%)	*MeiMax* (ng/l)	Dose (g/ha)	SpArea (1000 ha)
1	2,4_D	2	40	0	0
2	Atrazine	9	30	0	0
3	Bentazone	36	20	523	91
4	Bromocynil	6	80	383	110
5	Carbofuran	0	0	659	1
6	Chloridazon	1	380	0	0
7	Chlorsulfuron	2	30	0	0
8	Cyanazin	2	200	0	0
9	Dichlorprop	7	70	847	2
10	Dimethoat	2	40	304	81
11	Ethofumesat	5	90	491	31
12	Fenpropimorph	2	70	477	249
13	Glyphosat	76	220	1172	573
14	Ioxynil	6	30	349	113

		Predicted variables *Set 1*		Predicting variables *Set 2*	
Id	Substances	*DetFreq* (%)	*MeiMax* (ng/l)	Dose (g/ha)	SpArea (1000 ha)
15	Isoproturon	40	130	2750	4
16	Maleinhydrazid	1	10	1790	0.3
17	MCPA	20	140	1410	101
18	Mecoprop	17	30	900	13
19	Metamitron	8	90	2098	48
20	Metribuzine	1	50	250	27
21	Metsulfuron methyl	1	10	5	151
22	Pendimethalin	12	40	1368	178
23	Pirimicarb	4	30	135	7
24	Propiconazole	6	20	6837	3
25	Terbuthylazine	33	100	1500	22

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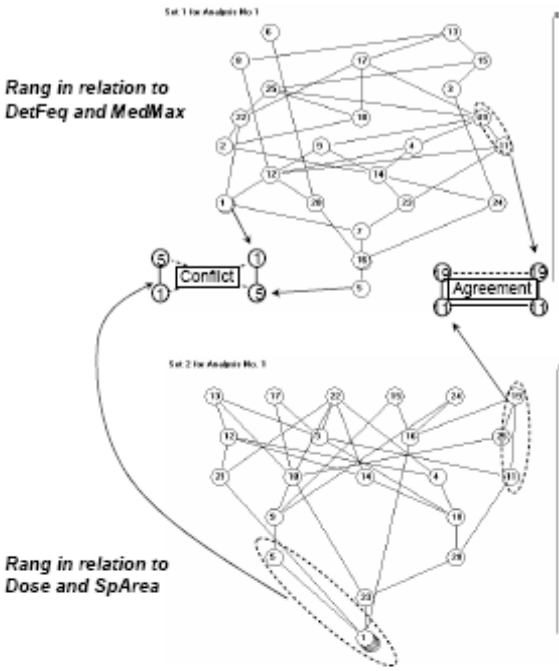


For substances that has been used during 2000:
Agreements: 51
Conflicts: 3

Emission is a strong driver

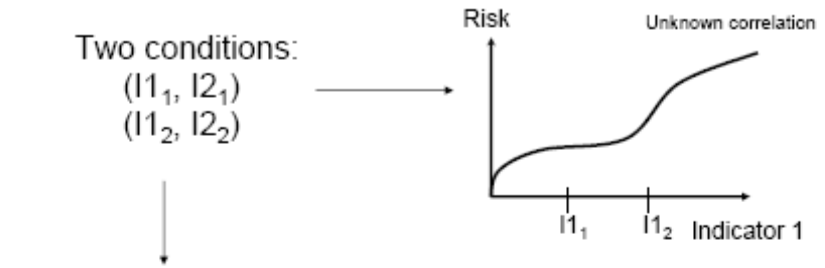
Sørensen et al. 2006

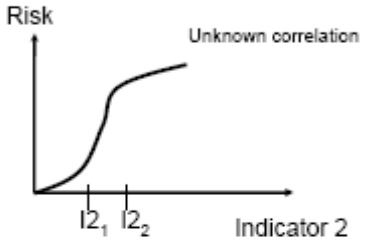
For terrestrial plant indicator: Based only on glyphosate, it was ***not*** possible to falsify the indicator.

Sørensen et al. 2006

Ordinal verification

Two conditions:
$(I1_1, I2_1)$
$(I1_2, I2_2)$





If both Indicator 1 and 2 are valid:
$I1_2 > I1_1 \Leftrightarrow I2_2 > I2_1$

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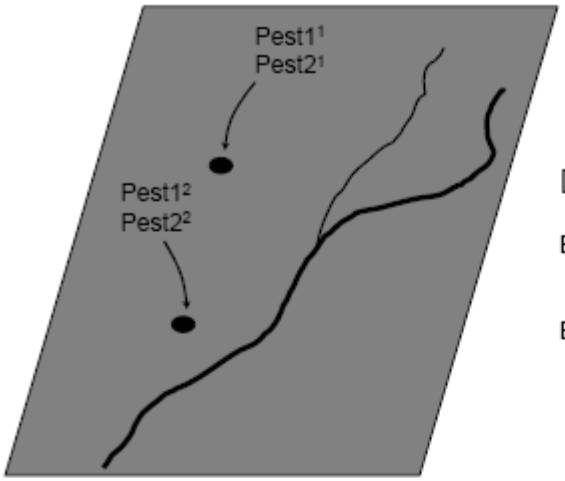
The runoff exposure indicator

$$C_{sw} = C_{drift} + \left(L_{runoff} + L_{drainage} + L_{erozion}\right) \cdot e^{\frac{\ln 2 \cdot (t - \Delta t)}{DT50_{water,ke}}} \cdot \frac{d \cdot 0.1}{w \cdot d - d^2}$$

Neglecting: Drainage, Erosion and temporal changes….

Sørensen et al. 2006



Selected for further analysis

Differences:

Between substances:
Pest1[1]-Pest2[1]

Between locations:
Pest1[1]-Pest1[2]

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Test for relative separation ***only*** due to differences between the chemical properties and application rate between two active ingredients:

- ***Env***: Environmental conditions like lengths, slope, Climate and environmental chemical conditions in soil, air and water
- ***Tech***: Technological variables like spraying technique etc
- ***AR***: Application rate
- ***Chem***: Chemical properties of the specific active ingredient

Sørensen et al. 2006

$$C_{sw} = C_{drift}(AR, Tech, Env) + \left(L_{runoff}(AR, Chem, Env)\right) \cdot \frac{d \cdot 0.1}{w \cdot d - d^2}$$

where

$$L_{runoff} = AR \cdot e^{-\Delta t \frac{\ln 2}{DT50_{soil,ev}}} \cdot \frac{1-I}{1+K_d} \cdot \frac{Q}{P} \cdot f_1 \cdot f_2$$

For investigation of the relative difference between two pesticides at same site at maximum run-off:

$$\frac{AR}{1+K_d} : \frac{AR}{Chem}$$

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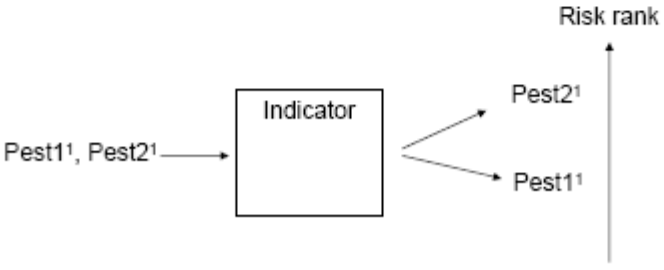
Ordinal verification

Time scale: Worst case short after application (t ***not*** >> DT50)

Test: relative separation of active ingredients



Increase in complexity has the burden of proof

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Two models M1 and M2, where M1 is completely included in M2 and thus M2 more complex than M1:

M1: AR and M2: $AR/(1+Kd)$

If M2 can certainly change a decision made by M1, then the increased complexity of M2 is necessary otherwise the model M1 is best.

Occam's Razor: "***Entities should not be multiplied beyond necessity*** "

Sørensen et al. 2006

Data from Danish EPA

Id	Name	AR (g/ha)	Kd (l/kg)
1	Aclonifen	1474	113
2	alpha-cypermethrin	12	906
3	Asulam	606	1,22
4	Azoxystrobin	272	5,89
5	Bentazon	523	0,52
6	Bromoxynil	383	3,00
7	Carbofuran	659	0,47
8	Chlormequat Chloride	980	24,35
9	Chlorothalonil	1249	44,86
10	Clopyralid	141	0,13
11	Cyprodinil	400	31,15
12	Diflufenican	102	30,72
13	Dimethoate	304	0,36
14	Diquat	1360	14631
15	Esfenvalerate	10	21,40

Id	Name	AR (g/ha)	Kd (l/kg)
16	Ethephon	664	12,77
17	Ethofumesate	491	38,47
18	Fenoxaprop-P-ethyl	69	92,25
19	Fenpropidin	748	42,05
20	Fenpropimorph	477	38,60
21	Flamprop-M-isopropyl	598	2,03
22	Fluazifop-P-butyl	340	0,19
23	Fluazinam	200	26,56
24	Fluroxypyr	159	0,01
25	Glyphosate	1172	75,20
26	Glyphosate-Trimesium	1887	52,71
27	Haloxyfop ethoxyethylester	169	0,81
28	Ioxynil	349	11,82
29	Lambda-cyhalothrin	8	1473
30	Linuron	1000	8,25

Sørensen et al. 2006

Data from Danish EPA

Id	Name	AR (g/ha)	Kd (l/kg)
31	Maleinhydrazid	1787	0,89
32	Mancozeb	1591	9,60
33	MCPA	1410	0,75
34	Mepiquat-chlorid	598	24,09
35	Metaldehyd	499	0,38
36	Metamitron	2098	1,57
37	Methabenzthiazuron	2113	7,67
38	Metribuzin	250	1,55
39	Metsulfuron methyl	5	0,38
40	Napropamide	482	6,77
41	Pendimethalin	1368	57,45
42	Phenmedipham	761	36,00
43	Pirimicarb	135	3,05
44	Prochloraz	433	93,96

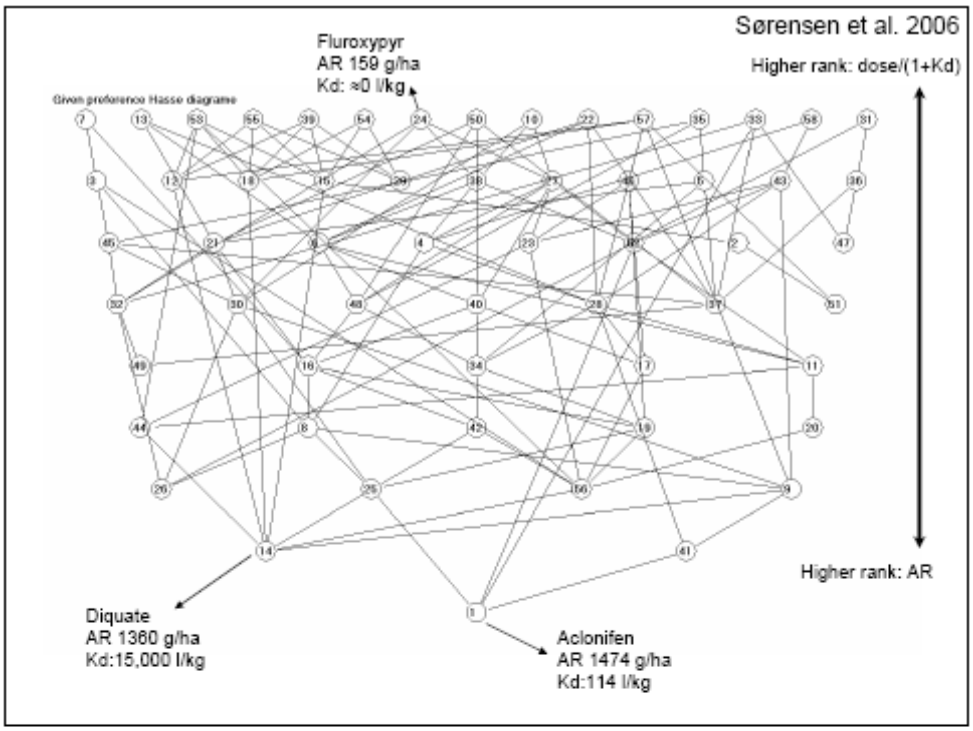
Id	Name	AR (g/ha)	Kd (l/kg)
45	Propamocarb	1000	1,85
46	Propaquizafop	118	5,18
47	Propiconazole	6837	11,94
48	Propyzamid	501	5,30
49	Prosulfocarb	2798	21,16
50	Pyridate	479	0,63
51	Tau-fluvalinate	60	10913
52	Tebuconazol	259	15,90
53	Thifensulfuron-methyl	8	0,21
54	Triasulfuron	4	2,05
55	Tribenuron methyl	8	0,73
56	Trifluralin	830	137
57	Triflusulfuron methyl	45	0,58
58	Trinexapac-ethyl	133	1,85

Sørensen et al. 2006

Do the differences in chemical properties influence the ordering of the active ingredients?

For two substances (A and B):

Set A>B if and only if:
$AR_A < AR_B$ **and** $AR_A/(1+K_{d,mean,A}) > AR_B/(1+K_{d,mean,B})$



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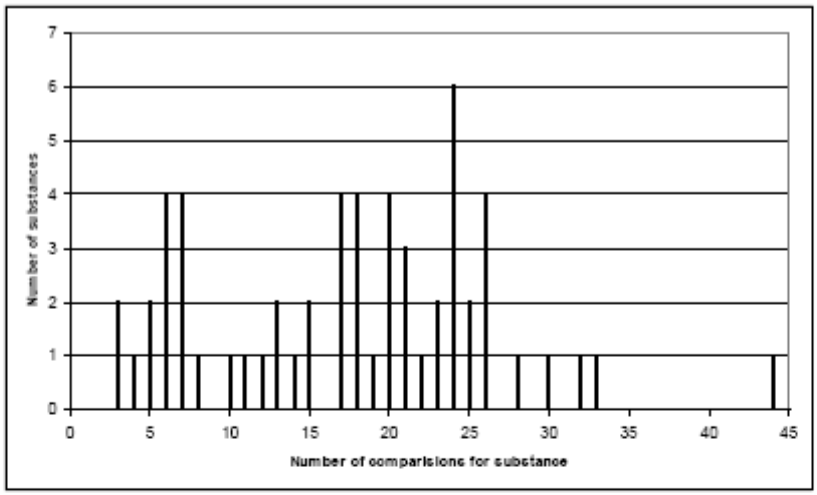
Total number of rankings: 58·57/2=***1653***

Number of rankings, where the rankings using AR is changed when AR/(1+Kd) is used instead: ***509***

The Kd parameter has some influence if the value setting is completely certain



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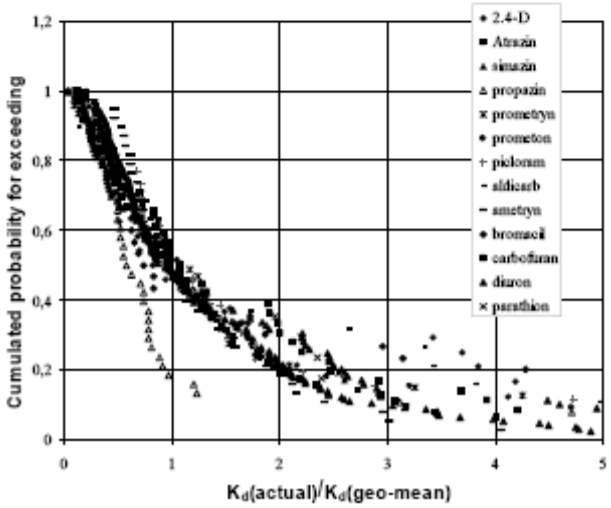
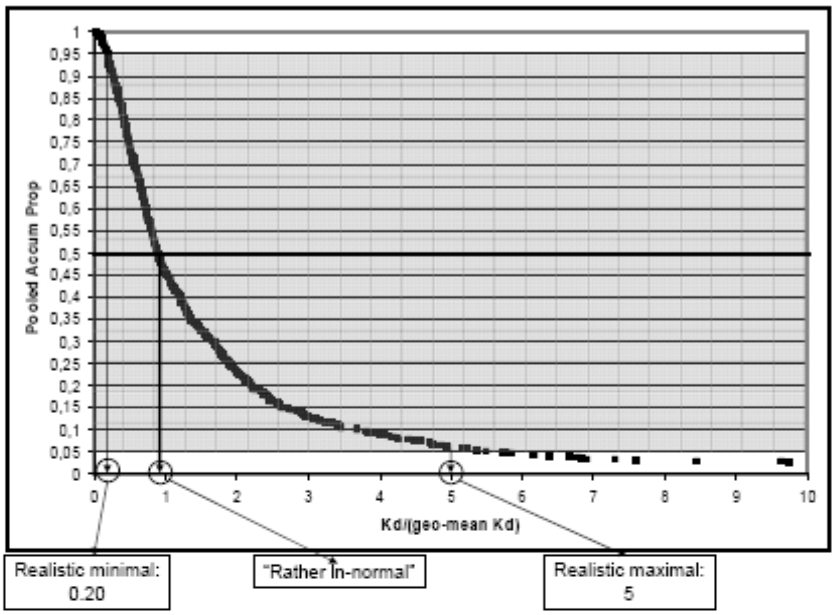
The K_d is not without uncertainty



Sørensen et al. 2006

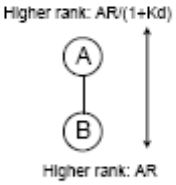


Sørensen et al. 2006

For two substances (A and B)

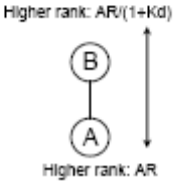
Set A>B if and only if:

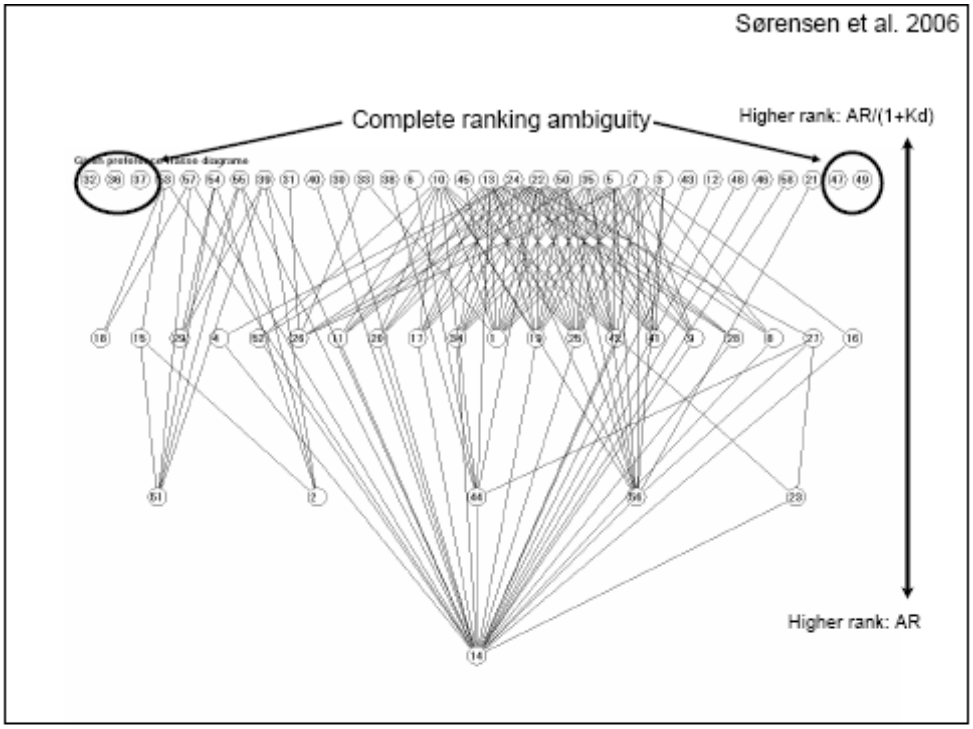
$AR_A < AR_B$ **and** $AR_A/(1+K_{d,max,A}) > AR_B/(1+K_{d,min,B})$

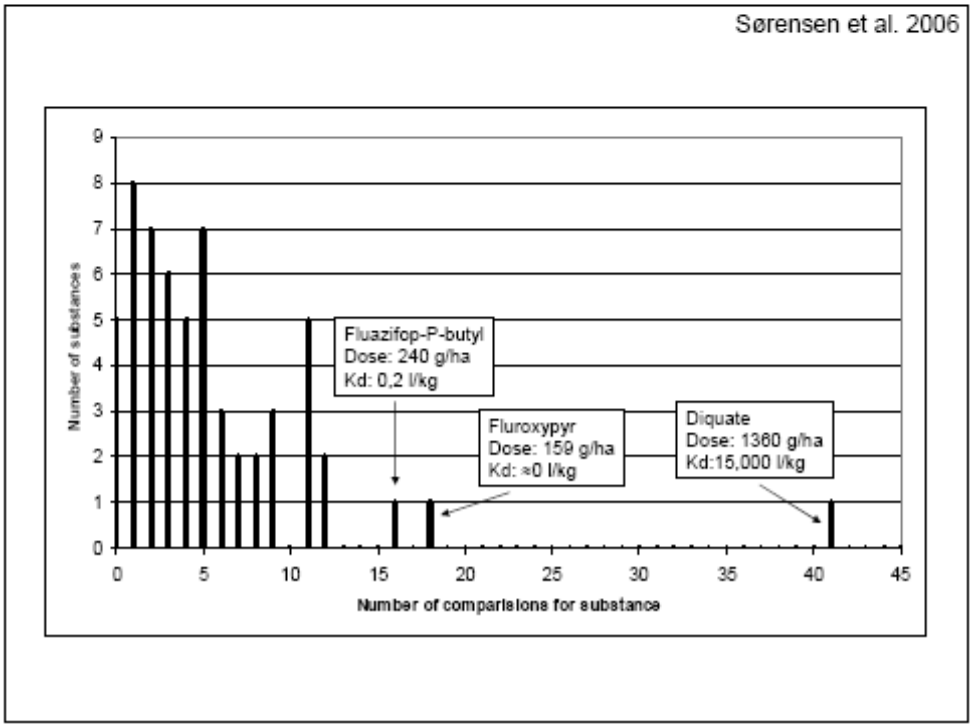


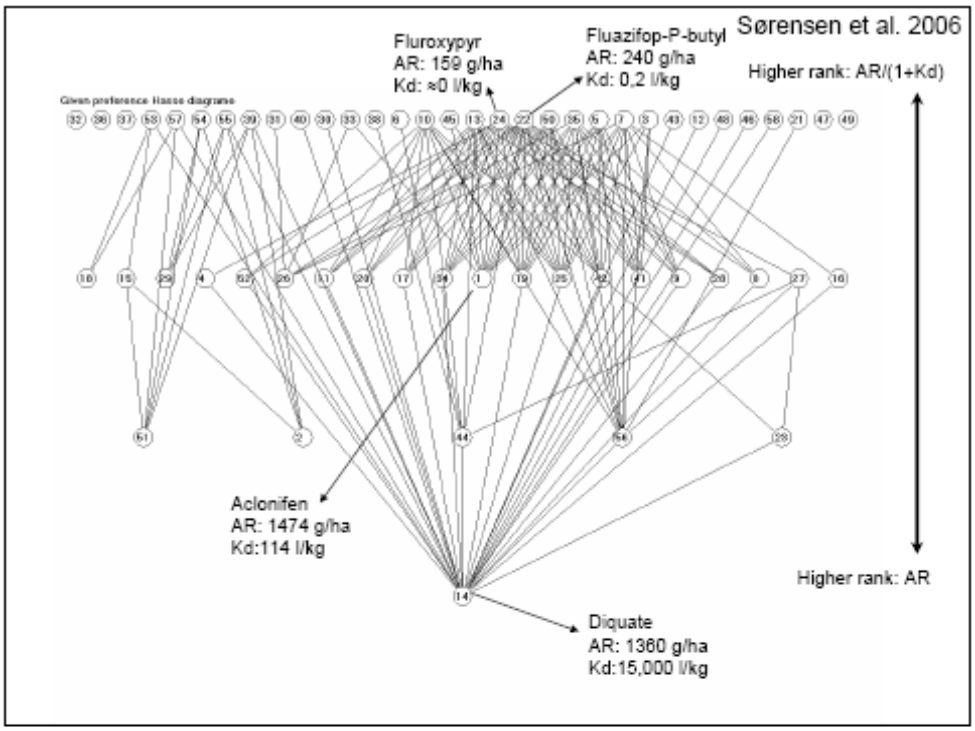
Set A<B if and only if:

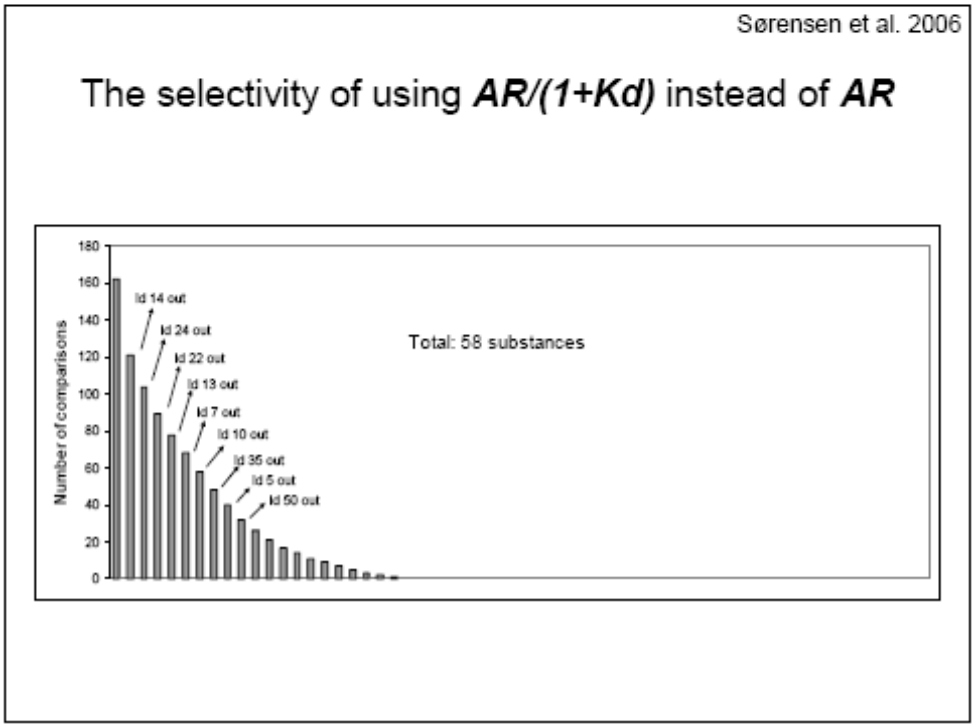
$AR_A > AR_B$ **and** $AR_A/(1+K_{d,min,A}) < AR_B/(1+K_{d,max,B})$



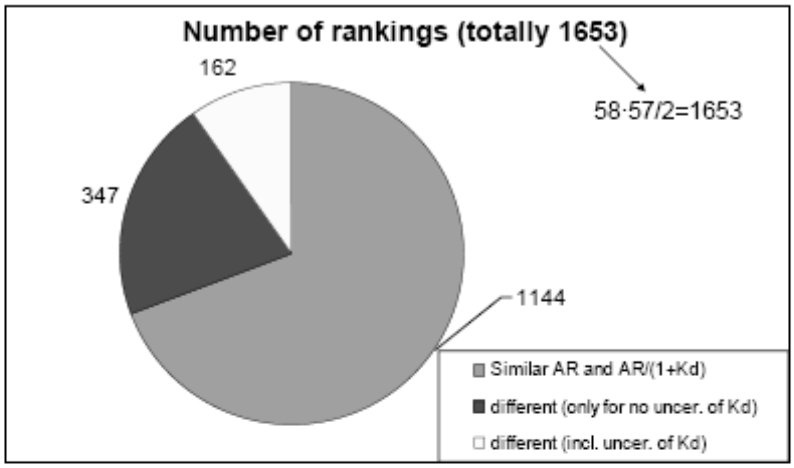

Sørensen et al. 2006
Complete ranking ambiguity
Higher rank: AR/(1+Kd)
Higher rank: AR


Sørensen et al. 2006
Number of substances
Number of comparisons for substance
Fluazifop-P-butyl
Dose: 240 g/ha
Kd: 0,2 l/kg
Fluroxypyr
Dose: 159 g/ha
Kd: ≈0 l/kg
Diquate
Dose: 1360 g/ha
Kd:15,000 l/kg


Sørensen et al. 2006
Fluroxypyr
AR: 159 g/ha
Kd: ≈0 l/kg
Fluazifop-P-butyl
AR: 240 g/ha
Kd: 0,2 l/kg
Higher rank: AR/(1+Kd)
Given preference Hasse diagrams
Aclonifen
AR: 1474 g/ha
Kd:114 l/kg
Higher rank: AR
Diquate
AR: 1360 g/ha
Kd:15,000 l/kg


Sørensen et al. 2006
The selectivity of using AR/(1+Kd) instead of AR
Number of comparisons
Total: 58 substances
Id 14 out
Id 24 out
Id 22 out
Id 13 out
Id 7 out
Id 10 out
Id 35 out
Id 5 out
Id 50 out

Sørensen et al. 2006



Sørensen et al. 2006

Conclusion

- Hard to separate between different chemical properties of the substances
- Geographical correlation in application may still induce differences between substances
- General “fate zones” in the landscape colud be considered as replacement of single substance calculations
- The complexity of the indicator difficult to validate

HAIR
Risk aggregation

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W. Steurbaut

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CONTENTS:

- Definitions
- Method
- Walloon bees example
- Software implementation

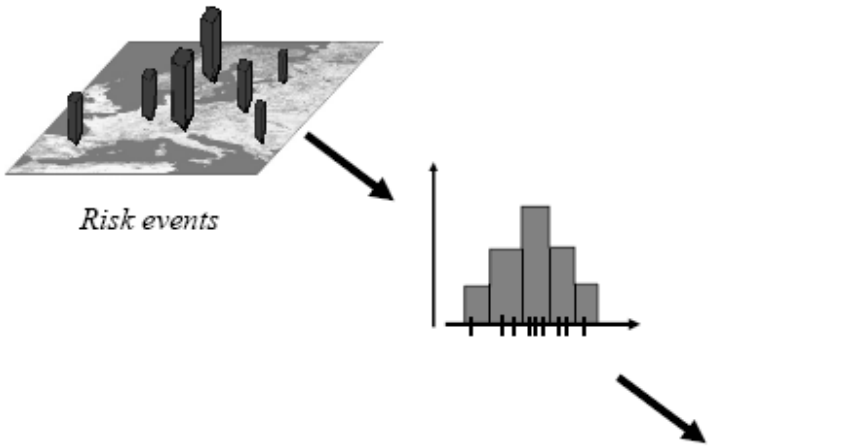
A) DEFINITIONS

Risk event

A risk event is:

the risk corresponding to a unitary time and area in which an individual is exposed to a single active substance, and for which only one hazard is considered

Risk distribution



Risk aggregations is seen as:

- a way to summarise information about a large number of risk events
- the events that are summarised are those corresponding to an aggregation question.

E.g.: What are the differences in acute bees risk between agricultural regions in Wallonia, for 2000 ?

Summarising is done through:

- statistics of risk events (tables)
- graphical representation (charts, maps)

B) METHOD

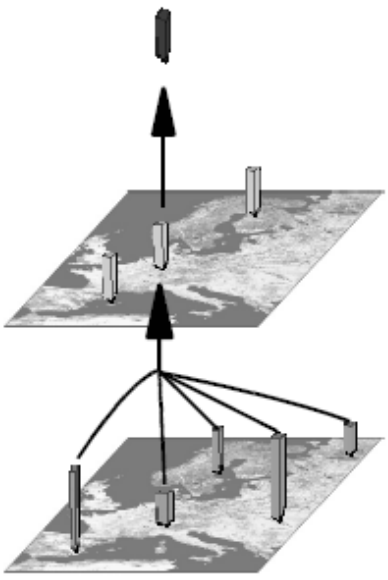
1.define aggregation question
2.do a query
3.obtain risk events table
4.aggregate using distributions, statistics, graphs and maps

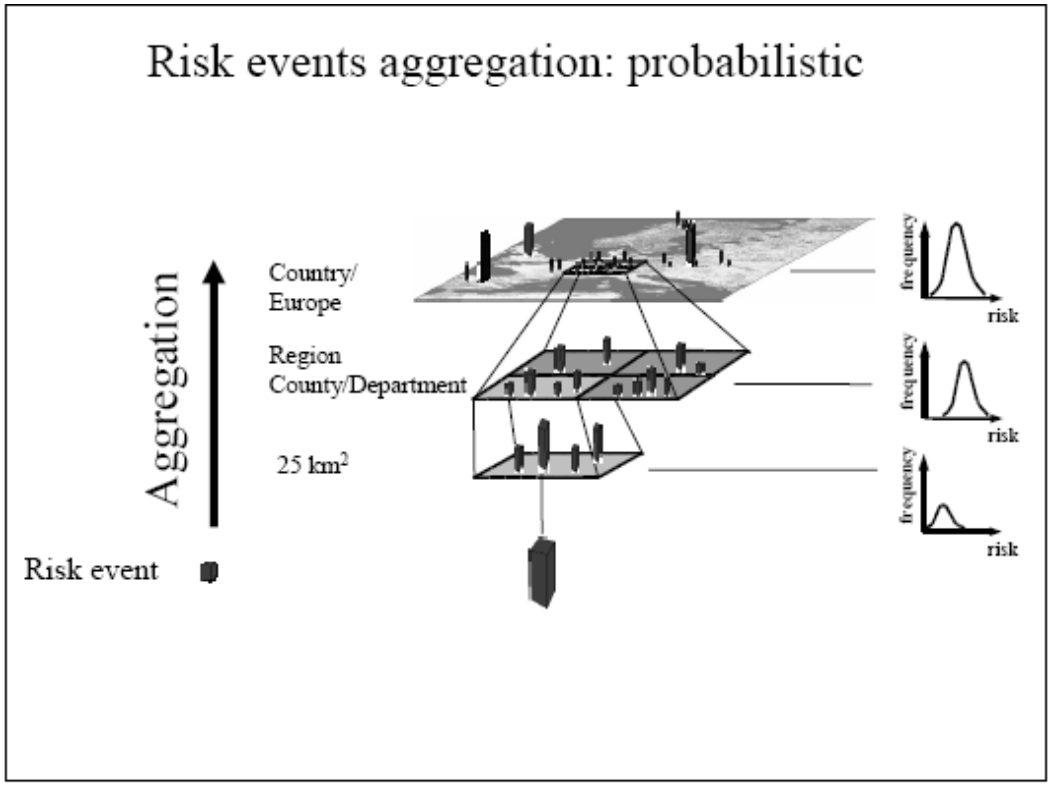
Events

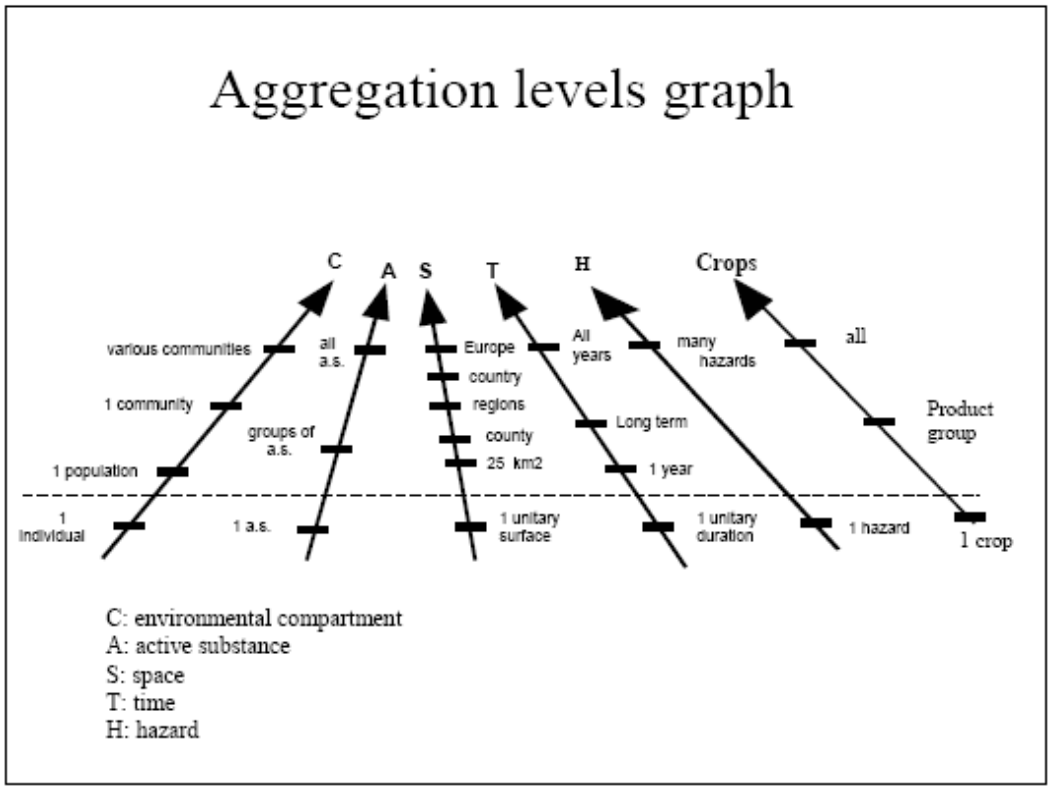
Risk event

Exposure event

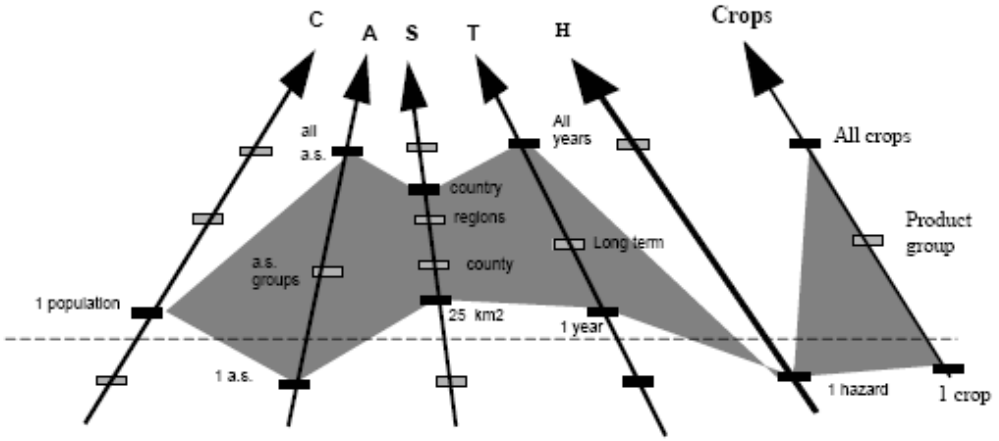
Emission event




Risk events aggregation: probabilistic
Aggregation
Country/
Europe
Region
County/Department
25 km2
Risk event
frequency
risk
frequency
risk
frequency
risk


Aggregation levels graph
C
A
S
T
H
Crops
various communities
1 community
1 population
1 Individual
all a.s.
groups of a.s.
1 a.s.
Europe
country
regions
county
25 km2
1 unitary surface
All years
Long term
1 year
1 unitary duration
many hazards
1 hazard
all
Product group
1 crop
C: environmental compartment
A: active substance
S: space
T: time
H: hazard

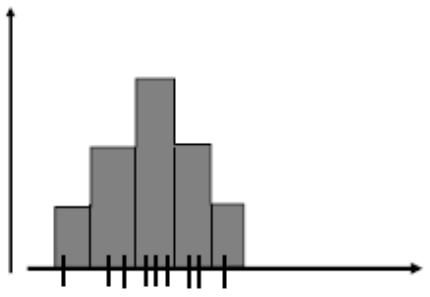
HAIR Maximal and minimal aggregation level



C: environmental compartment
A: active substance
S: space
T: time
H: hazard

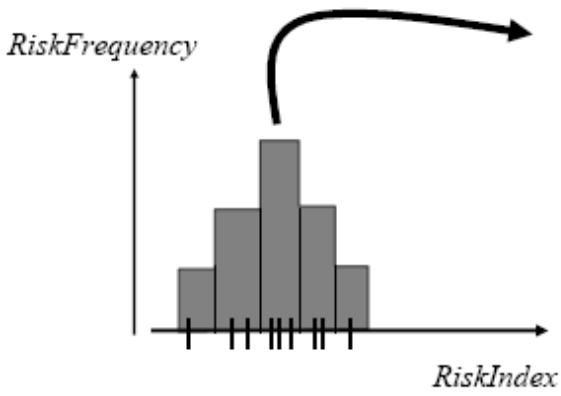
Risk events distribution

$$RiskFrequency = \frac{\#\ of\ risk\ events}{total\ \#\ of\ risk\ events} = f\left(\frac{sales}{dose}\right)$$



$$RiskIndex = EXP/TOX$$

Aggregated Risk



Statistics:
- Mean
- Percentiles

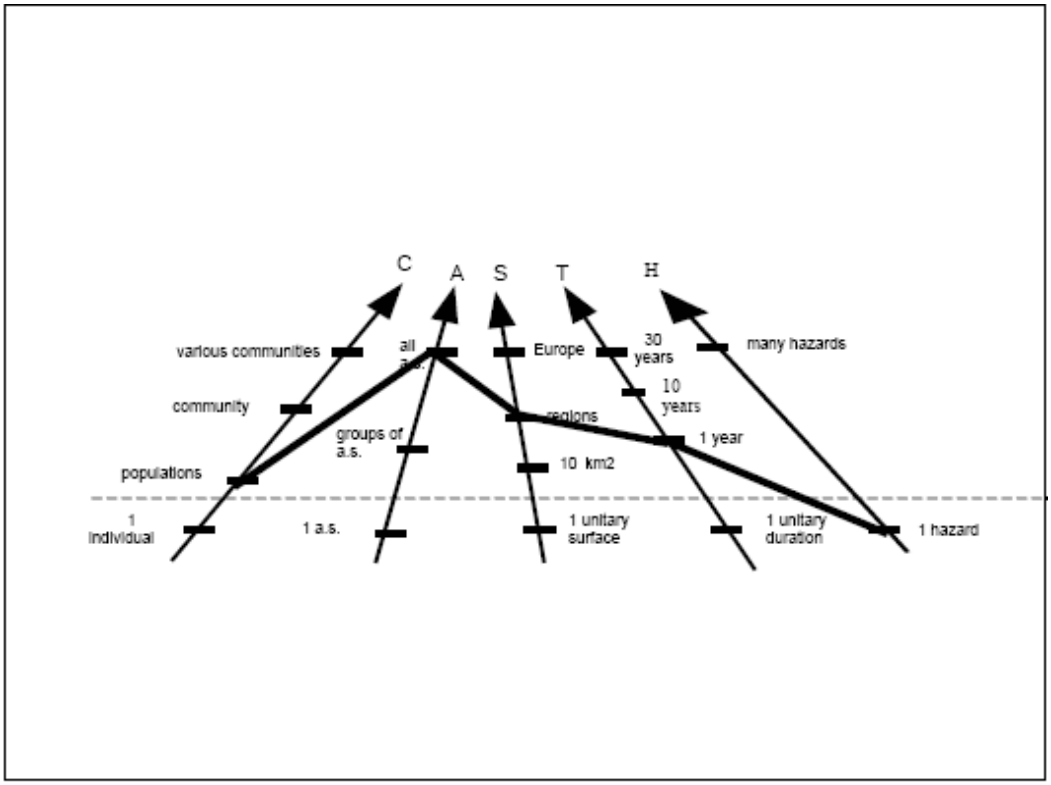
Other aggregation:
- $sum = \sum (\text{Risk x Freq})$
- max(sum)

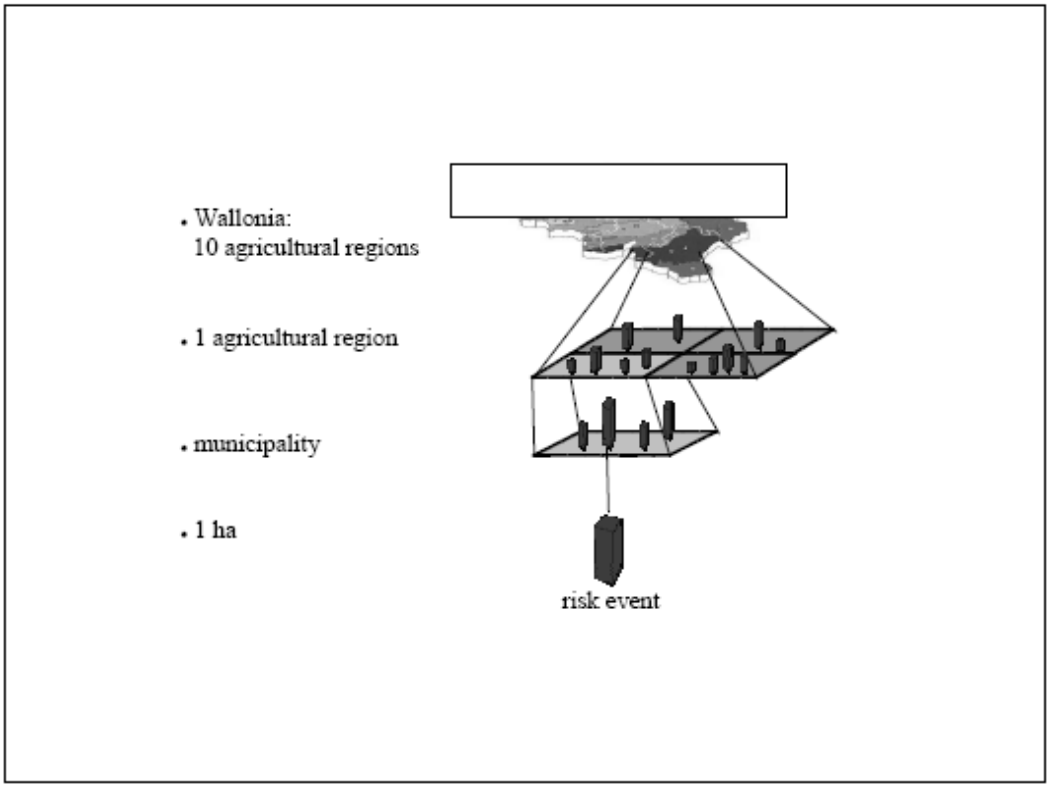
C) AGGREGATION IMPLEMENTATION: THE WALLOON BEES CASE

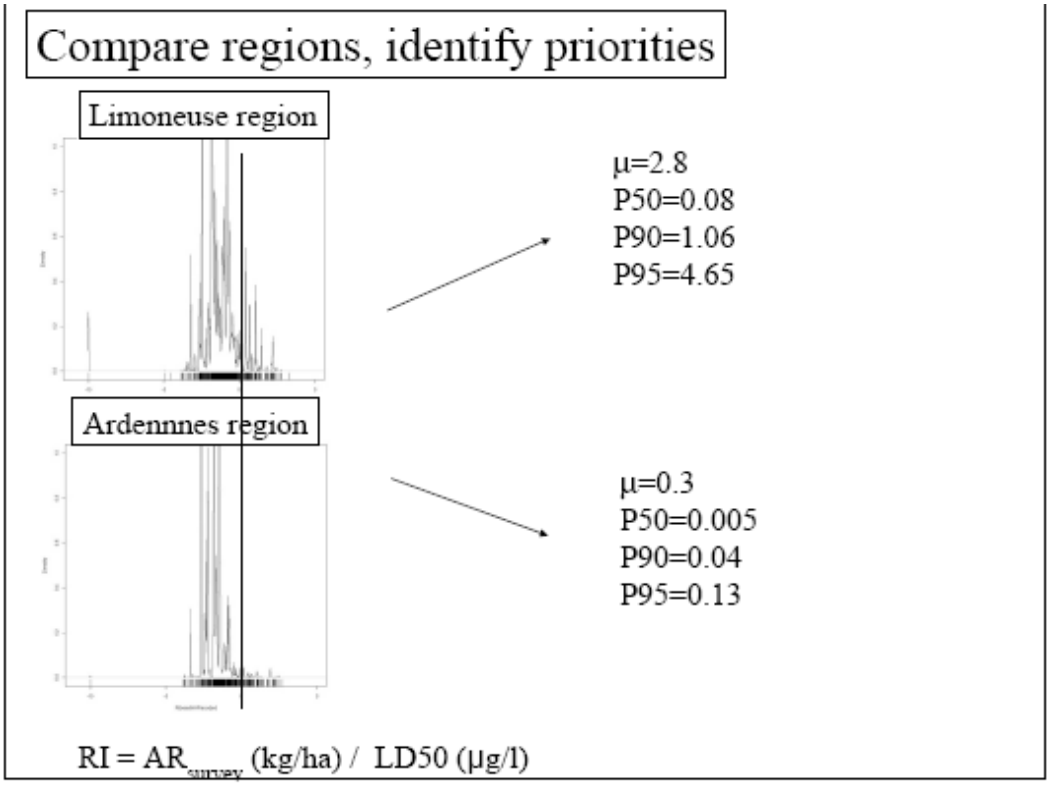
Aggregation question:

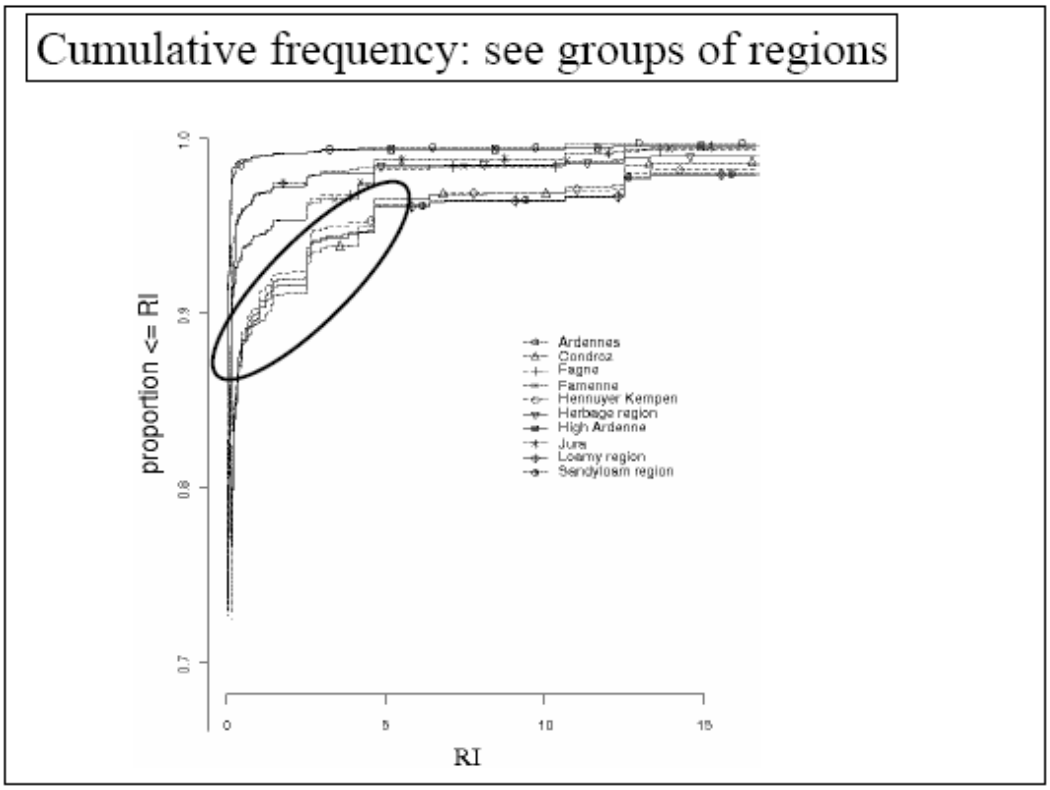
What are the differences in acute bees risk between agricultural regions in Wallonia, for 2000 ?

→
- ***C:*** *corresponds to bees components*
- ***A:*** *all*
- ***S:*** *are located in one of the 10 agricultural regions*
- ***T:*** *2000*
- ***H:*** *LD50 bees*
- ***Crops:*** *all*

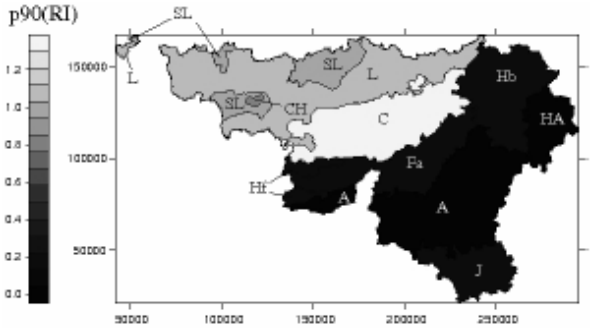

C
A
S
T
H
various communities
community
populations
1
individual
all
a.s.
groups of
a.s.
1 a.s.
Europe
regions
10 km2
1 unitary
surface
30
years
10
years
1 year
1 unitary
duration
many hazards
1 hazard


• Wallonia:
10 agricultural regions
• 1 agricultural region
• municipality
• 1 ha
risk event


Compare regions, identify priorities
Limoneuse region
μ=2.8
P50=0.08
P90=1.06
P95=4.65
Ardennnes region
μ=0.3
P50=0.005
P90=0.04
P95=0.13
RI = AR survey (kg/ha) / LD50 (μg/l)

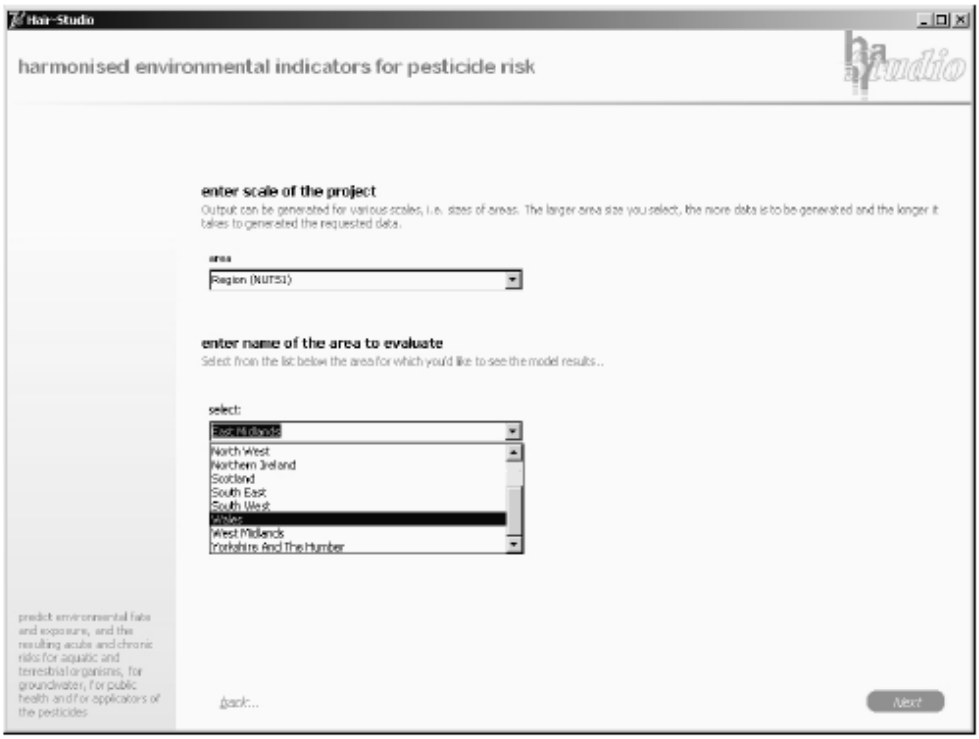

Cumulative frequency: see groups of regions
proportion <= RI
RI
Ardennes
Condroz
Fagne
Famenne
Hennuyer Kempen
Herbage region
High Ardenne
Jura
Loamy region
Sandyloam region

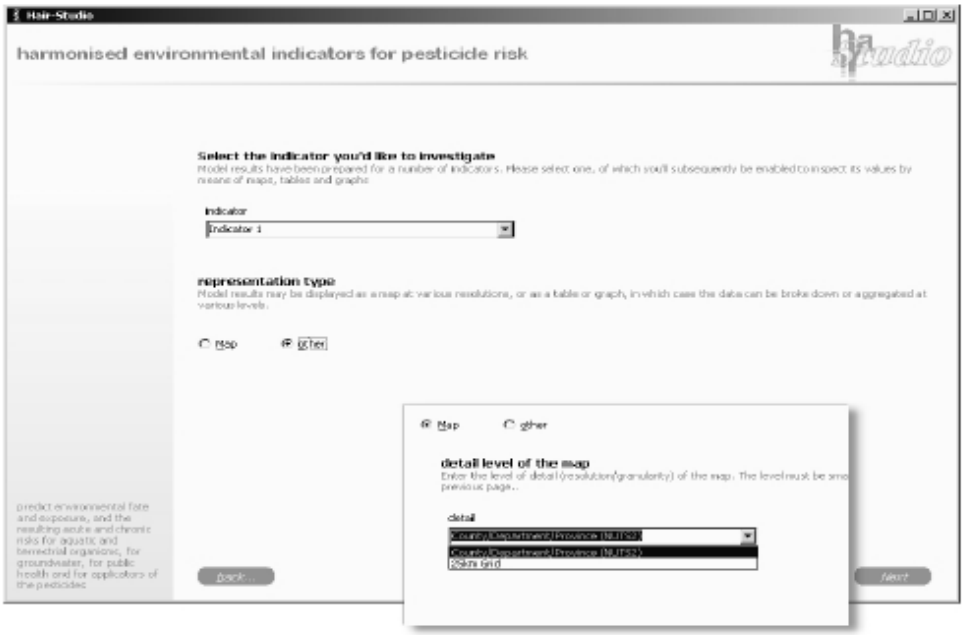
Generate maps of risk percentiles



D) Implementation in the HAIR software

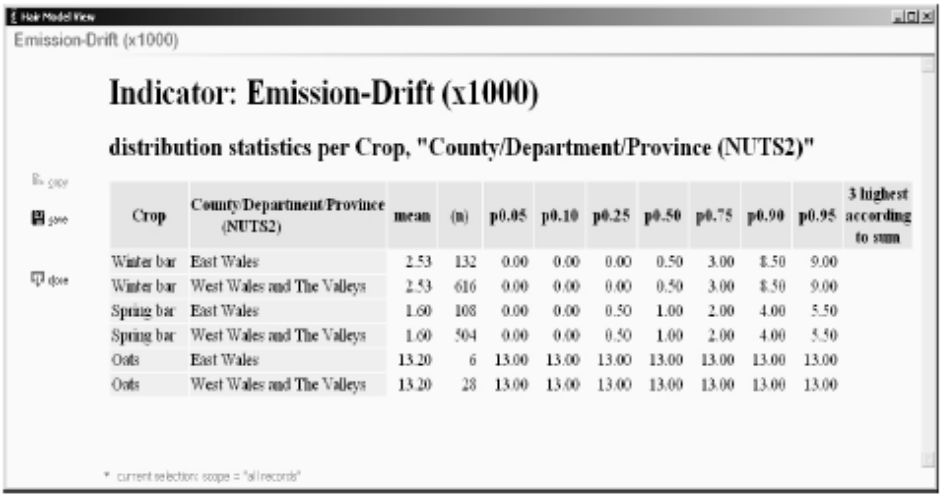
Aggregation question definition



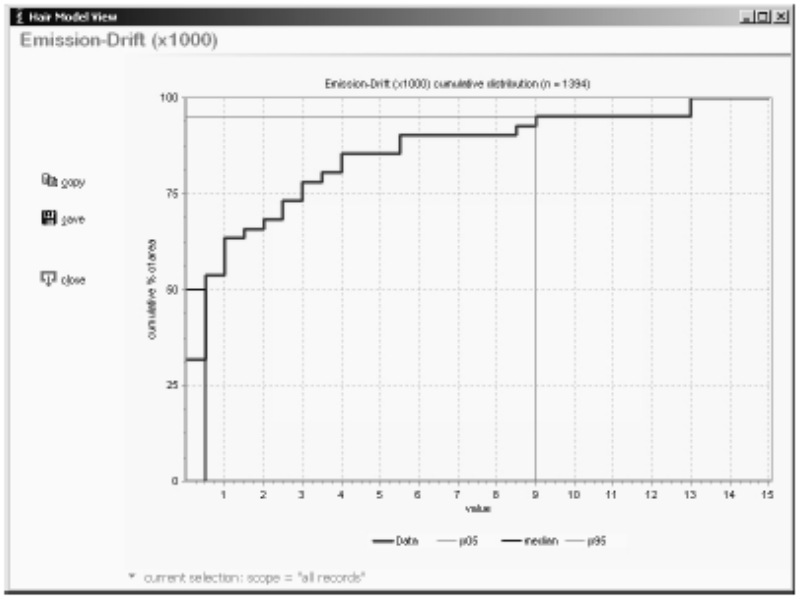

Hair-Studio
harmonised environmental indicators for pesticide risk
Select the indicator you'd like to investigate
Indicator
Indicator 1
representation type
Map
other
detail level of the map
detail
predict environmental fate and exposure, and the resulting acute and chronic risks for aquatic and terrestrial organisms, for groundwater, for public health and for applicators of the pesticides
Back...
Next

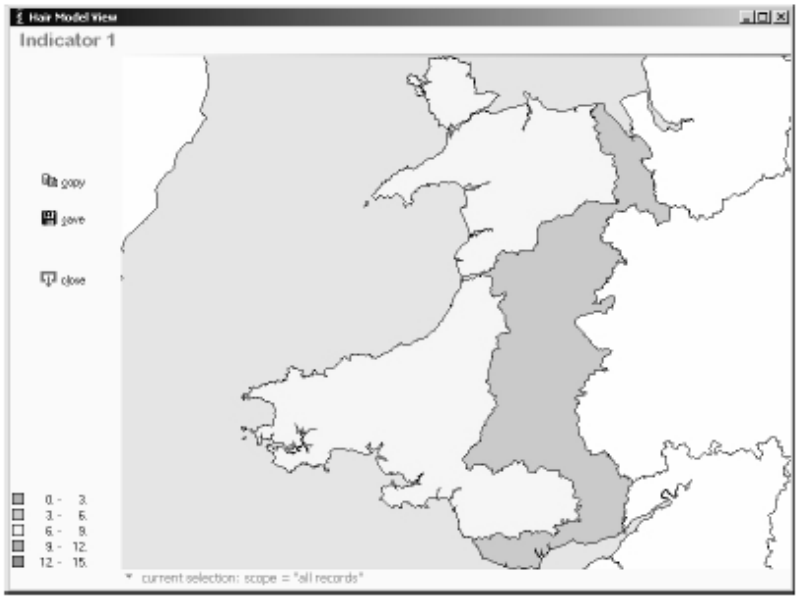

Hair-Studio
harmonised environmental indicators for pesticide risk
break-down options
By default, output values are aggregated to a general mean. Here you can select the categories and levels by which more detailed views on the data will be generated.
Active Substance
none (lump all together)
group of a.s.
single a.s.
Crop
none (lump all together)
Crop
Product group
Scale
none (lump all together)
Country/Department/Province (NUTS2)
Time
none (lump all together)
long term
one year
predict environmental fate and exposure, and the resulting acute and chronic risks for aquatic and terrestrial organisms, for groundwater, for public health and for applicators of the pesticides
Back...
Next

Aggregation statistics and maps



Crop	County/Department/Province (NUTS2)	mean	(n)	p0.05	p0.10	p0.25	p0.50	p0.75	p0.90	p0.95	3 highest according to sum
Winter bar	East Wales	2.53	132	0.00	0.00	0.00	0.50	3.00	8.50	9.00	
Winter bar	West Wales and The Valleys	2.53	616	0.00	0.00	0.00	0.50	3.00	8.50	9.00	
Spring bar	East Wales	1.60	108	0.00	0.00	0.50	1.00	2.00	4.00	5.50	
Spring bar	West Wales and The Valleys	1.60	504	0.00	0.00	0.50	1.00	2.00	4.00	5.50	
Oats	East Wales	13.20	6	13.00	13.00	13.00	13.00	13.00	13.00	13.00	
Oats	West Wales and The Valleys	13.20	28	13.00	13.00	13.00	13.00	13.00	13.00	13.00	


Hair Model View
Emission-Drift (x1000)
Emission-Drift (x1000) cumulative distribution (n = 1394)
copy
save
close
cumulative % of area
value
Data
p05
median
p95
current selection: scope = "all records"


Hair Model View
Indicator 1
copy
save
close
0. - 3.
3. - 6.
6. - 9.
9. - 12.
12. - 15.
current selection: scope = "all records"