ENVIRONMENT DIRECTORATE
JOINT MEETING OF THE CHEMICALS COMMITTEE AND
THE WORKING PARTY ON CHEMICALS, PESTICIDES AND BIOTECHNOLOGY

OEC5 SERIES ON PESTICIDES
Number 40

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

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


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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.
This publication is available electronically, at no charge.

For the complete text of this and many other Environment, Health and Safety publications, consult the OECD’s World Wide Web site (http://www.oecd.org/ehs/)

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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 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.
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<td>Introduction to the background of the joint seminar and of the project (10 minutes) Wolfgang Zornbach</td>
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<td>Introduction to Sixth Framework Programme (FP6). (10 minutes) Danièle Tissot (DG Research, European Commission)</td>
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<td>Introduction to HAIR (10 minutes) Robert Luttik (RIVM, The Netherlands)</td>
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<td><strong>DATA REQUIREMENTS FOR APPLICATION</strong></td>
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<td>GIS DATA (10 minutes) Declan Mulligan (JRC, Italy)</td>
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<td>COMPOUNDED RELATED DATA (toxicity and fate) (10 minutes) Peter van Vlaardingen (RIVM, The Netherlands)</td>
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<td>USE AND USAGE DATA (20 minutes) Miles Thomas (CSL, UK)</td>
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<td>TERRESTRIAL INDICATORS (15 minutes) Villie Flari (CSL, UK)</td>
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<td>CONSUMER INDICATORS (15 minutes) Marco Trevisan (Università Cattolica del Sacro Cuore, Italy)</td>
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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 Aggregation (Juan Piñeros, University of Gent, Belgium)
Robert Luttik | 13 November 2006

Harmonised environmental indicators for pesticide risk (HAIR)

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 database: 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/rys/overige/risbecoor/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 be 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

Declan Mulligan - JRC
Bonn 13\textsuperscript{th} 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_LAE_A)  
  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 
  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 HARNET10K 
  (450 rows x 450 columns)

- 25 km x 25 km Grid HARNET25K 
  (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 from 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 (ESBN) – JRC. 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.
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

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- 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.
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.

- Data: Long-term average Temperature and Precipitation
- Source: (MARS) The Monitoring Agriculture and Regional Information Systems
- Original data: MARS 50 km Grid (projection LAEA S/48 not 10/56)
- Monthly and annual values derived
- New 50 km x 50 km grid created
- Data linked to 10 km and 25 km grids
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 Wintensen, 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)
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 seamless 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)

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
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 beeoral, LD50 beecontact
   - LD50 duck, quail; LC50 bird (various species); NOEL bird
   - LR50 non target arthropods
   - Soil microbial parameters (e.g. biomass, respiration, $N_2$ fixation, etc.)

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
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)

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
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

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 worthwhile, 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
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

Compound property database – detail

- Within HAIR all datasets contain one value per parameter
e.g. atrazine – 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 $K_{ow}$, $K_{cm}$
  - geometric mean for DT50

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

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 ($LC_{50}$).

acute risk potential \hspace{1cm} chronic risk potential

$$ETR_{acute} = \frac{sPEC}{LC_{50 \ species}} \quad ETR_{chronic} = \frac{iPEC}{NOEC \ species}$$

$ETR_{species}$  Exposure-Toxicity-Ratio
$sPEC$ short-term exposure in the surface water
$iPEC$ long-term exposure in the surface water
$LC_{50 \ species}$ Lethal concentration
$NOEC \ species$ No effect concentration

Calculation of $sPEC$: acute risk

1. order degradation T-dependent

1. single application a.i. on day $t_1$

2. first application ($i=1$) of the a.i. on day $t_2$

3. second application ($i=2$) of the a.i. on day $t_3$

4. $i^{th}$ application ($i=n$) of the a.i. on day $t_n$

Drift + Run-off + Drainage

Input parameter of the model

C(t) C(t1) C(t2) C(tn)

Input parameter of the model

$PEC = \max_{i=1}^{n} C(t_i)$

$PEC = 0.121$
Calculation of *IPEC*: chronic risk

1. Order degradation
   T-dependent

1. Single application a.i. on day \( t_0 \)
2. First application (\( n=1 \)) of the a.i. on day \( t_1 \)
3. Second application (\( n=2 \)) of the a.i. on day \( t_2 \)
4. \( n \)th application (\( n=n \)) of the a.i. on day \( t_n \)

Drift + Run-off + Drainage

Input parameter of the models

\[ C(t) = \frac{\int C(t) \, dt}{t_{\text{end}}} \]

\[ IPEC = \max \left( \frac{C(t) \cdot t}{t_{\text{end}}} \right) \]

Three cases of data availability

<table>
<thead>
<tr>
<th>Pesticide use</th>
<th>application conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>environment</td>
<td>crop</td>
</tr>
</tbody>
</table>

**Case 1**
- Field related application patterns
- 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 availability

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 availability

- **Assign application patterns** randomly to the fields

- **Pesticide use**:
  - pesticide used
  - application rate
  - application date

- **Field related application patterns** from field based survey
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
- landscape (CORINE)
- crop
- slope
- soil parameters
- climate data
- distance to surf. water
type of surf. water
- use default surface waters
Environmental data for case 2

- The water index

\[ W = \frac{\text{length}_{\text{swall}} \cdot \text{area}_{\text{arable}}}{\text{area}_{\text{grid}}} \cdot \frac{1}{\text{area}_{\text{grid}}} \]

\[ ETR(\text{grid}) = ETR_{SW1} \cdot W \]

- It describes the potential of a field being close to a surface water within the grid.
- Calculate ETR by using the default SW-types and a default minimal distance of 1 m.

Environmental and geographical parameters:
- Arable land
- Land cover (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

- 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

\[ ETR_{\text{acute(daphnia)}} \] was calculated without multiplying by the water index.

#### Case 2

#### Case 1

---

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

\[ ETR_{\text{acute(daphnia)}} \] was calculated multiplying by the water index.

#### Case 2

#### Case 1

---

---

---
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.

<table>
<thead>
<tr>
<th>Nr</th>
<th>country</th>
<th>Pesticide</th>
<th>Pesticide ID</th>
<th>Crop</th>
<th>ETR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Iprodion</td>
<td>410</td>
<td>wheat</td>
<td>0.011</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Dithianon</td>
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<td>wheat</td>
<td>0.0002</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>Fenpropathrin</td>
<td>600</td>
<td>wheat</td>
<td>0.03</td>
</tr>
<tr>
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<td>1</td>
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<td>wheat</td>
<td>0.044</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Flupyradifurin</td>
<td>925</td>
<td>wheat</td>
<td>0.0006</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>2,4-D</td>
<td>27</td>
<td>wheat</td>
<td>0.07</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td></td>
<td></td>
<td>...</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>1</td>
<td>Flupyradifurin</td>
<td>925</td>
<td>wheat</td>
<td>0.0038</td>
</tr>
</tbody>
</table>
Comparison of the acute risk indicator calculated with case1 and case3 data availability

$E_{TR}^{acute(daphnie)}$ was calculated multiplying by the water index.

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
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
Terrestrial risk indicators

- Outline of assessed (& not assessed) risks and groups of organisms

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Terrestrial risk indicators

- Outline of assessed (& not assessed) risks and groups of organisms
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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
### 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
Plan of terrestrial risk indicators

Based upon most recent regulatory approaches


Plan of terrestrial risk indicators

Based upon most recent regulatory approaches

- 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

- 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
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

Outcome

Usage Data

ETR

A NUMBER
Plan of terrestrial risk indicators

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

Design: Reflects first tier regulatory decision making schemes

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
Possible exposure routes for vertebrates in the field (E.U. 2002)

---

**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

**Estimated Theoretical Exposure (ETE)**

or

**Daily Dietary Dose (DDD)**

<table>
<thead>
<tr>
<th>Reasonable Worst Case (RWC)</th>
<th>Most Likely Case (MLC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(as introduced in EU Guidance Documents &amp; EPPO, 2003)</td>
<td>(as introduced in EPPO, 2003)</td>
</tr>
</tbody>
</table>

- Crop
- Bird indicator species
- Exposure standard scenario

---

### BAsic Bird Risk Indicator

#### Phase I: Estimation of Exposure

**a. Crop → Indicator species**

<table>
<thead>
<tr>
<th>Reasonable Worst Case (RWC)</th>
<th>Most Likely Case (MLC)</th>
</tr>
</thead>
</table>
**BAsic Bird Risk Indicator**

**Phase I: Estimation of Exposure**

a. **Crop → Indicator species**

<table>
<thead>
<tr>
<th>Reasonable Worst Case (RWC)</th>
<th>Most Likely Case (MLC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herbivorous (3000g)</td>
<td>Herbivorous (3000g)</td>
</tr>
<tr>
<td>Insectivorous (10g)</td>
<td></td>
</tr>
</tbody>
</table>

| Herbivorous (3000g)         | Omnivorous (300g)      |
BAsic Bird Risk Indicator

**Phase I: Estimation of Exposure**

**a. Crop → Indicator species**

<table>
<thead>
<tr>
<th>Reasonable Worst Case (RWC)</th>
<th>Most Likely Case (MLC)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Herbivorous (3000g)</strong></td>
<td><strong>Herbivorous (3000g)</strong></td>
</tr>
<tr>
<td>Cereal shoots</td>
<td>Cereal shoots</td>
</tr>
<tr>
<td><strong>Insectivorous (10g)</strong></td>
<td></td>
</tr>
<tr>
<td>Insects</td>
<td></td>
</tr>
<tr>
<td><strong>Herbivorous (300g)</strong></td>
<td><strong>Omnivorous (300g)</strong></td>
</tr>
<tr>
<td>Non-grass herbs</td>
<td>33% non-grass herbs</td>
</tr>
<tr>
<td></td>
<td>33% insects</td>
</tr>
<tr>
<td></td>
<td>33% seeds</td>
</tr>
</tbody>
</table>

**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 Acute Exposure

c. Calculations (Crocker et al., 2002)
Estimated Theoretical Exposure (ETE) or Daily Dietary Dose (DDD)

\[
ETE = \frac{FIR}{BW} \times C \times AV \times PT \times PD
\]

- **FIR**: Food Intake Rate [g fresh weight food/day]
- **BW**: Body Weight [g]
- **C**: Concentration [mg a.s./kg fresh weight food]
- **AV**: Avoidance
- **PT**: proportion of diet from treated area
- **PD**: proportion of food type in diet

<table>
<thead>
<tr>
<th>RWC</th>
<th>MLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>1</td>
<td>Depends on species</td>
</tr>
</tbody>
</table>

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### 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)**

\[
\text{ETE} = [\text{FIR/BW}] \times C \times AV \times PT \times PD
\]

<table>
<thead>
<tr>
<th>ETE</th>
<th>[mg a.s./kg BW/day]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIR</td>
<td>[g fresh weight food/day]</td>
</tr>
<tr>
<td>DEE</td>
<td>[kJ/day]</td>
</tr>
<tr>
<td>MC</td>
<td>[kJ dry weight food]</td>
</tr>
<tr>
<td>AE</td>
<td>%</td>
</tr>
<tr>
<td>C</td>
<td>[mg a.s./kg fresh weight food]</td>
</tr>
<tr>
<td>RUD</td>
<td>[mg a.s./kg fresh weight food]</td>
</tr>
<tr>
<td>AR</td>
<td>Application Rate</td>
</tr>
<tr>
<td>MAF</td>
<td>Multiple Application Factors</td>
</tr>
<tr>
<td>AV</td>
<td>Avoidance</td>
</tr>
<tr>
<td>PT</td>
<td>proportion of diet from treated area</td>
</tr>
<tr>
<td>PD</td>
<td>proportion of food type in diet</td>
</tr>
</tbody>
</table>

| 1 | 1 |
| 0.5 | 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)**

\[
\text{ETE} = [\text{FIR/BW}] \times C \times AV \times PT \times PD
\]

<table>
<thead>
<tr>
<th>ETE</th>
<th>[mg a.s./kg BW/day]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIR</td>
<td>[g fresh weight food/day]</td>
</tr>
<tr>
<td>DEE</td>
<td>[kJ/day]</td>
</tr>
<tr>
<td>MC</td>
<td>[kJ dry weight food]</td>
</tr>
<tr>
<td>AE</td>
<td>%</td>
</tr>
<tr>
<td>C</td>
<td>[mg a.s./kg fresh weight food]</td>
</tr>
<tr>
<td>RUD</td>
<td>[mg a.s./kg fresh weight food]</td>
</tr>
<tr>
<td>AR</td>
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</tr>
<tr>
<td>MAF</td>
<td>Multiple Application Factors</td>
</tr>
<tr>
<td>AV</td>
<td>Avoidance</td>
</tr>
<tr>
<td>PT</td>
<td>proportion of diet from treated area</td>
</tr>
<tr>
<td>PD</td>
<td>proportion of food type in diet</td>
</tr>
</tbody>
</table>

| 1 | 1 |
| 0.5 | Depends on species |

---

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**Basic Bird Risk Indicator**

**Phase I: Estimation of Chronic Exposure**

**c. Calculations** *(Crocker et al., 2002)*

Estimated Theoretical Exposure (ETE) - sum for 3 weeks

<table>
<thead>
<tr>
<th>ETE</th>
<th>[mg a.s./kg BW/day]</th>
</tr>
</thead>
<tbody>
<tr>
<td>[FIR/BW]<em>C</em>AV<em>PT</em>PD</td>
<td>[g fresh weight food/day]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEE: Daily Energy Expenditure</th>
<th>[kcal/day]</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE: Food Energy</td>
<td>[g dry weight food]</td>
</tr>
<tr>
<td>MC: Metabolism constant</td>
<td>[%]</td>
</tr>
<tr>
<td>AE: Assimilation Efficiency</td>
<td>[%]</td>
</tr>
<tr>
<td>C: Cₐ<em>MAF</em>f_mis</td>
<td>[mg a.s./kg fresh weight food]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AR: Application Rate</th>
<th>[kg a.s./ha]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWC</td>
<td>MLC</td>
</tr>
<tr>
<td>AV: Avoidance</td>
<td>1</td>
</tr>
<tr>
<td>PT: proportion of diet from treated area</td>
<td>1</td>
</tr>
<tr>
<td>PD: proportion of food type in diet</td>
<td>1 Depends on species</td>
</tr>
</tbody>
</table>

---

---

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---

---
Basic Bird Risk Indicator

• Vegetation: exponential degradation is assumed

\[ C = C_0 \times MAF \times f_{\text{ads}} \quad [\text{mg a.s. / kg fresh weight food}] \]

\[ \text{Co: Initial concentration after a single application} \quad [\text{mg a.s. / kg fresh weight food}] \]

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

\[ MAF = \frac{1 - e^{-\frac{k_i}{l}}} {1 - e^{-\frac{DT_{50}}{l}}} \]

\( k = \text{number of applications} \)
\( i = \text{interval between applications} \)

\[ f_{\text{ads}} : \quad \text{Time Weighted Averaged Factors} \quad \text{when DT}_{50}<10 \text{ days} \]

\[ f_{\text{ads}} = \frac{1 - e^{-kt}} {k + t} \]

\( k = \ln(2)/DT_{50} \quad \text{velocity constant} \)
\( t = \text{averaging time} \)

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\textsubscript{50} or NOEC for same species

Chronic

\( \text{LC}_{50} \text{ or GM LC}_{50} \quad \rightarrow \quad \text{Daily Dose} \quad [\text{mg a.s.} / \text{kg BW} / \text{day}] \)

\( (\text{LC}_{50} \times \text{FIR}) / \text{BW} \)

---

Basic Bird Risk Indicator

Phase II: Estimation of Toxicity

b. Extrapolation factors

Number of species for which LD\textsubscript{50} are available

\(<6 \quad \geq 6\)
BASic Bird Risk Indicator

Phase II: Estimation of Toxicity
b. Extrapolation factors

Number of species for which $LD_{50}$ are available

\[
\begin{align*}
\text{\( < 6 \)} & \quad \text{\( \geq 6 \)} \\
\text{(Luttik \& Aldenberg, 1997)} & \quad \text{(Aldenberg \& Slob, 1993)}
\end{align*}
\]

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

$GM$: Geometric Mean
$EF$: Extrapolation Factor

EFs for: median
95% CL

5th percentile SSD = $10 \log_{10} \left( \text{mean toxicity figure} \cdot \text{EF} \cdot \text{SD} \right)$

$SD$: Standard Deviation

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

<table>
<thead>
<tr>
<th>AR (kg/ha)</th>
<th>ETR</th>
<th>Toxicity figure</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.255</td>
<td>1</td>
<td>0.32</td>
<td>Root crops: Aldicarb</td>
</tr>
<tr>
<td>0.25</td>
<td>5826</td>
<td>188.7</td>
<td>Wheat: Carbendazim</td>
</tr>
<tr>
<td>0.72</td>
<td>32</td>
<td>3.6</td>
<td>Wheat: Chlorpyrifos</td>
</tr>
<tr>
<td>0.675</td>
<td>10.50</td>
<td>0.9</td>
<td>Wheat: Dimethoate</td>
</tr>
</tbody>
</table>

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

**Assessed by the BAsic Birds Risk Indicator**

<table>
<thead>
<tr>
<th>AR (g/ha)</th>
<th>ETR&lt;sub&gt;RWC&lt;/sub&gt;</th>
<th>Toxicity figure</th>
<th>Classification of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.255</td>
<td>1012.54</td>
<td>1</td>
<td>High risk</td>
</tr>
<tr>
<td>0.25</td>
<td>0.015</td>
<td>5826</td>
<td>Low risk</td>
</tr>
<tr>
<td>0.72</td>
<td>2.07</td>
<td>32</td>
<td>High risk</td>
</tr>
<tr>
<td>0.675</td>
<td>5.73</td>
<td>10.50</td>
<td>High risk</td>
</tr>
</tbody>
</table>

1. Granules consumed intentionally as grit
2. Spraying standard scenario
3. Lowest (or single) LD<sub>10</sub> (RWC) or 5<sup>th</sup> percentile SSD (MLC)

### Notes
- **ETR<sub>RWC</sub>**
- **AR**
- **Toxicity figure**
- **Classification of risk**

---

## Worked examples

**Assessed by the BAsic Birds Risk Indicator**

<table>
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<tr>
<th>AR (g/ha)</th>
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<td>0.675</td>
<td>5.73</td>
<td>10.50</td>
<td>High risk</td>
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</table>

1. Granules consumed intentionally as grit
2. Spraying standard scenario
3. Lowest (or single) LD<sub>10</sub> (RWC) or 5<sup>th</sup> percentile SSD (MLC)

---

**Notes**
- **ETR<sub>RWC</sub>**
- **AR**
- **Toxicity figure**
- **Classification of risk**

---

### References
- 4. Aldicarb
- 5. Carbendazim
- 6. Chlorpyrifos
- 7. Dimethoate

---

### Additional Details
- RWC-MLC: Herbivorous (300g)
- RWC-MLC: Herbivorous (3000g)
**Worked examples**

Assessed by the BAsic Birds Risk Indicator

<table>
<thead>
<tr>
<th>AR (kg/ha)</th>
<th>ETR_{RWC}</th>
<th>Toxicity figure</th>
<th>Classification of risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.255</td>
<td>1012.54</td>
<td>1</td>
<td>Risk requiring refined assessment and/or mitigation</td>
</tr>
<tr>
<td>0.25</td>
<td>0.015</td>
<td>5826</td>
<td>Risk below screening level</td>
</tr>
<tr>
<td>0.72</td>
<td>2.07</td>
<td>32</td>
<td>Risk requiring refined assessment and/or mitigation</td>
</tr>
<tr>
<td>0.675</td>
<td>5.73</td>
<td>10.50</td>
<td>Risk requiring refined assessment and/or mitigation</td>
</tr>
</tbody>
</table>

1. Granules consumed intentionally as grit
2. Spraying standard scenario
3. Lowest (or single) LD_{50} (RWC) or 5th percentile SSD (MLC)

**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

![Graph showing area treated (ha) from 1990 to 2002](image)
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

Area treated (ha)


2000000 1600000 1200000 800000 400000 0

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

Area treated (ha)


2000000 1600000 1200000 800000 400000 0

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 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 treated (ha)

- Area for which risk is below 0.1
- Area for which risk is above 0.1 and below 0.15
- Area for which risk is above 0.15 and below 0.2

Worked examples—aggregation along organisms

- Various communities
- All as a group
- UK regions (7)
- Many hazards: many application events
- 1 individual
- 1 community
- 1 population
- 1 hazard
- Aldicarb
- Amitoxin
- Carbendazim
- Chlorpyrifos
- Dinoseb
- Efenvlurate
- Isoproturon
- Lambda-cyhalothrin
- Metatoluron-methyl
- Fenthiuvinlate

Eastern
Midlands-Western
Northern
Scotland
Southern Eastern
Southern Western
Wales

WPS: USAGE DATA
Worked examples—aggregation along organisms

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

<table>
<thead>
<tr>
<th>Crop</th>
<th>Region</th>
<th>Active</th>
<th>Month</th>
<th>Area treated</th>
<th>Earthworms</th>
<th>Bees</th>
<th>Birds</th>
<th>Mammals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ETR Score</td>
<td>ETR Score</td>
<td>ETR Score</td>
<td>ETR Score</td>
</tr>
<tr>
<td>Wheat winter</td>
<td>Emir</td>
<td>Chlopyrifos</td>
<td>Jan</td>
<td>573</td>
<td>0.11</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wheat winter</td>
<td>Emir</td>
<td>Chlopyrifos</td>
<td>Feb</td>
<td>545</td>
<td>0.11</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wheat winter</td>
<td>Emir</td>
<td>Chlopyrifos</td>
<td>March</td>
<td>630</td>
<td>0.11</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wheat winter</td>
<td>Emir</td>
<td>Chlopyrifos</td>
<td>June</td>
<td>1238</td>
<td>0.11</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wheat winter</td>
<td>Dera</td>
<td>Chlopyrifos</td>
<td>Oct</td>
<td>63</td>
<td>0.11</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wheat winter</td>
<td>Dera</td>
<td>Chlopyrifos</td>
<td>Nov</td>
<td>72</td>
<td>0.11</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Crop growth phases

<table>
<thead>
<tr>
<th>Crop</th>
<th>Time</th>
<th>Intermediates</th>
<th>Vertebrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter wheat</td>
<td>Sep to Mid Nov</td>
<td>Stage 1: Seedling</td>
<td>Phase 1: early</td>
</tr>
<tr>
<td>Winter wheat</td>
<td>Late Nov to Early Apr</td>
<td>Stage 2: Seedling</td>
<td>Phase 1: early</td>
</tr>
<tr>
<td>Winter wheat</td>
<td>Mid Apr to Early June</td>
<td>Stage 3: Flowering</td>
<td>Phase 2: late</td>
</tr>
<tr>
<td>Winter wheat</td>
<td>Mid Jul</td>
<td>Stage 4: Maturing</td>
<td>Phase 2: late</td>
</tr>
<tr>
<td>Winter wheat</td>
<td>Late Jul to Mid Aug</td>
<td>Stage 5: Senescence Ripening</td>
<td>Phase 2: late</td>
</tr>
</tbody>
</table>

Worked examples—aggregation along organisms

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

<table>
<thead>
<tr>
<th>Crop</th>
<th>Region</th>
<th>Active</th>
<th>Month</th>
<th>Area treated</th>
<th>ETR</th>
<th>Bees</th>
<th>Birds</th>
<th>Mammals</th>
</tr>
</thead>
</table>

Earthworms | Bees | Birds | Mammals

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 (HD₃)
  - 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
Further indicators – Canada: Pierre Mineau

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  - Toxicity (HD₅)
  - Application Rate
- Physicochemical characteristics of pesticides
  - Henry’s Law Constant (HLC)

Two major outputs

- Probability (p) of acute avian mortality
  \[ P = \frac{e^{x \cdot (TP + DTI - HLC)}}{1 + e^{x \cdot (TP + DTI - HLC)}} \]
- Application rate predicted to cause p of avian mortality

Further indicators – Canada: Pierre Mineau

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### Further indicators – Canada: Pierre Mineau

<table>
<thead>
<tr>
<th>Application rate</th>
<th>HD₅ equivalents * HD₅ * 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>TP = Log₁₀(HD₅ equivalents)</td>
<td></td>
</tr>
</tbody>
</table>

### Further indicators – Canada: Pierre Mineau

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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 (CR) is calculated by taking into account a 15g insectivorous species
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 (Cᵢ) is calculated by taking into account a 15g insectivorous species

Exposure

- Initial RUD in insects
- First rate order degradation, is assumed based on foliar DT₅₀
- Missing foliar DT₅₀ estimated by soil DT₅₀

---

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

![Graph showing the concentration of Mg a.i./kg FW insects over time with Cᵢ as a critical point.](image-url)
**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.
HAIR Groundwater Indicators

Contributors to the groundwater indicator

Ton van der Linden, RIVM, NL
Aaldrik Tiktak, MNP, NL
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

\[ \ln C_{FOCUS} = \alpha_0 + \alpha_1 \frac{k \theta L}{q} + \alpha_2 \frac{k_p f_{oc} K_{oc} L}{q} + \alpha_3 \frac{PSL}{q} \]

Analyses showed that the third term is not relevant

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

\[ \ln C_{FOCUS} = \alpha_0 + \alpha_1 \frac{k \theta}{q} + \alpha_2 \frac{k_p f_{om} K_{om}}{q} \]

- \( k \) is the first-order transformation rate coefficient, temperature corrected using the Arrhenius equation (d\(^{-1}\))
- \( \rho \) 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\(^{-1}\))
- \( \theta \) 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 ($C_{ROCS}$)
- the independent variables (see previous slide) were calculated with data, which are available in the EuroPEARL database
- soil properties ($f_{om}$ and $\rho$) are averaged over the top 1 m, $q$ and $\theta$ 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 points 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

<table>
<thead>
<tr>
<th>Climate zone</th>
<th>Annual temperature</th>
<th>Annual precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold and wet</td>
<td>&lt;12.5 deg C</td>
<td>&lt;800 mm/year</td>
</tr>
<tr>
<td>Cold and dry</td>
<td>&lt;12.5 deg C</td>
<td>&gt;800 mm/year</td>
</tr>
<tr>
<td>Warm and wet</td>
<td>&gt;12.5 deg C</td>
<td>&lt;800 mm/year</td>
</tr>
<tr>
<td>Warm and dry</td>
<td>&gt;12.5 deg C</td>
<td>&gt;800 mm/year</td>
</tr>
</tbody>
</table>
Fitting for separate climate zones is better

Example

Leaching concentration of FOCUS substance D
Autumn application

Leaching concentration of FOCUS substance D
Autumn application
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

Source: JRC
Application of MetaPEARL to substance A and D

Leaching concentration of FOCUS substance A
Autumn application

Leaching concentration of FOCUS substance D
Autumn application

\[ DT_{50} = 60, \ \text{K}_{\text{om}} = 60 \]

\[ DT_{50} = 20, \ \text{K}_{\text{om}} = 35 \]

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

Marco Trevisan, Maura Colliera
Istituto di Chimica Agraria Ambientale, Università Cattolica del Sacro Cuore, Facolta Agraria, Piacenza

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

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)

MONITORING DATA

YES

CROP RESIDUES

NO

PREDICTIVE MODELS

YES

MRL

NO

Step 1A- 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
Step 1A- 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: Predictive approach  Negative Aspects: Many variable need to be modelled for a realistic prediction

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

Step 1A- 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=FPR  no  Crop processed  yes  Monitoring data  no  TF

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

Food Pesticide Residues  Diet habits
Food consumption data:
- chronic
- acute

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.

\[
\begin{align*}
\text{HAPERITIF}_{\text{acute}} &= \frac{\text{ESTI}}{\text{ARfD}} \\
\text{HAPERITIF}_{\text{car}} &= \frac{\text{EDI}}{\text{ADI}}
\end{align*}
\]

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:
- \(Ra.i\) = 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

\[ \text{HAPERITIF}_{\text{CHR}} = \text{EDI/ADI} \]

Pear monitoring data - IT

### Table

<table>
<thead>
<tr>
<th>Year</th>
<th>Chemical</th>
<th>1</th>
<th>EDI</th>
<th>HAPERITIF CHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Azinphos</td>
<td>0.025</td>
<td>1.033</td>
<td>0.025</td>
</tr>
<tr>
<td>2003</td>
<td>Capan</td>
<td>0.035</td>
<td>0.384</td>
<td>0.035</td>
</tr>
<tr>
<td>2004</td>
<td>Carbofuran</td>
<td>0.055</td>
<td>0.702</td>
<td>0.055</td>
</tr>
<tr>
<td>2005</td>
<td>Chlorpyrifos</td>
<td>0.065</td>
<td>0.272</td>
<td>0.065</td>
</tr>
<tr>
<td>2006</td>
<td>Dichlor</td>
<td>0.075</td>
<td>0.684</td>
<td>0.075</td>
</tr>
<tr>
<td>2007</td>
<td>Diazinon</td>
<td>0.085</td>
<td>1.000</td>
<td>0.085</td>
</tr>
</tbody>
</table>

Several a.i. residues in a single commodity

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

\[ \text{HAPERITIF}_{(ac \ or \ chr.)} = \sum_{i=1}^{n} \frac{\text{EXP}_{a.i.}}{\text{TOX}_{a.i.}} \]

\( \text{EXP} = \text{Estimated Intake (Acute or Chronic)} \)

\( \text{TOX} = \text{ARfD or ADI} \)

**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

\[ \text{HAPERTIF}_\text{(chr.)} = \sum_{\text{crop}=1}^{r} \frac{\text{EXP}_{\text{crop,a.i.}}}{\text{TOX}_{\text{a.i.}}} \]

\(\text{EXP}\) = Estimated Intake (Chronic)
\(\text{TOX}\) = 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

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

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.
## Occupational Indicators for Pesticide Risk (WP 10)

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

**Veterinary and Agrochemical Research Centre**
Pilleros-Garocé, J.D., Van Bel, V. & Pussenier, L.

**ICPS**
International Centre for Pesticides and Health Risk Prevention
Vesentini, S. & Tironi, 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) = estimated human exposure toxicological endpoint
**Applicator Indicator**  

**Acute**

\[
RI_{\text{op, acute}} = \frac{IE_{\text{op, acute}} \times AR \times Area_{\text{target}}}{BW} \div AOEL
\]

\[
IE_{\text{operator}} = IE_{\text{man,load}} + IE_{\text{app}}
\]

\[
IE_{\text{man,load}} = (L_{\text{h}} \times \text{PPE}_{\text{h}} \times \text{Ab}_{\text{h}}) + (L_{\text{l}} \times \text{PPE}_{\text{l}} \times \text{Ab}_{\text{l}})
\]

\[
IE_{\text{app}} = (L_{\text{h}} \times \text{PPE}_{\text{h}} \times \text{Ab}_{\text{h}}) + (L_{\text{l}} \times \text{PPE}_{\text{l}} \times \text{Ab}_{\text{l}})
\]

**Chronic**

\[
RI_{\text{op, chronic}} = \frac{IE_{\text{op, chronic}} \times N_{\text{events}}}{AOEL} \div AOEL
\]

**Definitions:**
- \(RI_{\text{op, acute}}\): acute operator risk index
- \(IE_{\text{op, acute}}\): acute internal exposure operator (mg/kg bw/d)
- \(AOEL\): acceptable operator exposure level (mg/kg bw/d)
- \(BW\): body weight (default: 70 kg)
- \(AR\): application rate (kg a.s./ha)
- \(\text{PPE}_{\text{h}}\), \(\text{PPE}_{\text{l}}\), \(\text{PPE}_{\text{foot}}\): personal protective equipment coefficients
- \(L_{\text{h}}, L_{\text{l}}, L_{\text{foot}}\): (mg/kg a.s.) < EUROPEN
- \(\text{Ab}_{\text{h}}, \text{Ab}_{\text{l}}, \text{Ab}_{\text{foot}}\): inhalation, dermal absorption factor (-)

**Definitions:**
- \(RI_{\text{op, chronic}}\): chronic operator risk index
- \(IE_{\text{op, chronic}}\): chronic internal exposure operator (mg/kg bw/d)
- \(IE_{\text{op, acute}}\): acute internal exposure operator (mg/kg bw/d)
- \(AOEL\): acceptable operator exposure level (mg/kg bw/d)
- \(N_{\text{events}}\): number of exposure events (equal the frequency of application)
- \(AT\): averaging time (e.g. 365 days for year averaged exposure)
Re-Entry worker Indicator  

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

\[
DE = 0.001 \times DFR \times TF \times T \times P
\]

- **Declination pesticide residues**
  - exponential: \( DFR_\alpha = e^{a-bt}; \ln(DFR_\alpha) = a(R^2>0.85); \beta = \frac{\log(0.5)}{T_{50}} \)
  - logarithmic: \( \log(DFR_\alpha) = a - \beta \times \log(t) \)
  - ~ climatic factors (humidity, temperature,...), 
    physico-chemical properties

Re-Entry worker Indicator  

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

- dermal adherence concept
- minor contribution

- **Algorithm**: EUROPOEM II Re-Entry Working Group

\[
DE = \frac{C_{\text{act}} \times D_{\text{soil}} \times S_{\text{soil}} \times T_{\text{skin}}}{P_{\text{soil}}}
\]

- **Conc**: active substance soil concentration (mg/m³)
- **DAC**: dermal adherence of soil (mg/cm²) (default: 0.44 mg/cm²)
- **SA**: contaminated skin area (cm²) (default: 820 cm²)
- **P**: soil bulk density (g/cm³)
- **T**: transfer from soil to skin (°C)
**Re-Entry worker Indicator: Acute**

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

\[ I = AR \times TSF \times T \]

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

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Re-entry time</th>
<th>TSF</th>
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<tr>
<td>Cutting ornamentals</td>
<td>-</td>
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<tr>
<td>Sorting &amp; bundling ornamentals</td>
<td>-</td>
<td>0.01</td>
</tr>
<tr>
<td>Re-enter LV mist application</td>
<td>8</td>
<td>0.03</td>
</tr>
<tr>
<td>Re-enter roof logger</td>
<td>16</td>
<td>0.15</td>
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</tbody>
</table>

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

Typically very low risk: route not considered

---

**Re-Entry worker Indicator: Chronic**

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

\[ DE_{\text{chronic}} = DE_{\text{acute}} \times \frac{N_{\text{events}}}{AT} = DE_{\text{acute}} \times \frac{WD}{AT} \]

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

\[ I_{\text{chronic}} = I_{\text{acute}} \times \frac{N_{\text{events}}}{AT} = I_{\text{acute}} \times \frac{WD}{AT} \]

- \(DE_{\text{chronic}}\): chronic dermal exposure (mg/d)
- \(DE_{\text{acute}}\): acute dermal exposure (mg/d)
- \(I_{\text{chronic}}\): chronic inhalation exposure (mg/person/day)
- \(I_{\text{acute}}\): chronic inhalation exposure (mg/person/day)
- \(N_{\text{events}}\): Number of exposure events
- WD: estimated number of workdays (d) (expert judgment)
- AT: averaging time (d); yearly averaged chronic dose; AT = 265
Bystander & Resident Indicator

- 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

- Dermal exposure (mg a.s./person/day): spray drift
  \[ \text{DE} = \text{AR} \times \text{Drift} \times \text{EA} \times f_r \]
  \(\text{AR}\): application rate (mg a.s./m²)
  \(\text{Drift}\) (%/100) depending on crop type, crop stage & distance
  \(\text{EA}\): exposed area (m²/person/day) (default: 0.4225 m²/person/day)
  \(f_r\): reduction factor (improved spraying equipment)

<table>
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<tr>
<th>Arable Crops, Vines &amp; Vegetables</th>
<th>Fruit crops &amp; Hops</th>
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<tr>
<td>(X = 0) to (H)</td>
<td>(X &gt; H)</td>
</tr>
<tr>
<td>(\text{Drift} = A \times x^B \times f_r)</td>
<td>(\text{Drift} = A \times x^C \times f_r)</td>
</tr>
</tbody>
</table>

\(A, B, C, D, f_r\): regression parameters
\(x\): distance from the treated field (default: 0 m)
\(H\): hinge point
Bystander Indicator

- **I: Inhalation exposure (mg a.s./person/day)**
  - **EUROPOEM II approach**
    \[
    I = C_{\text{inhaled}} \times IR \times T \\
    C_{\text{inhaled}} = \text{Default} \times C_{\text{spray}}
    \]
    Def.: Airborne sprayers = 0.03 m³ spray/m² breached air
    Def.: Orchards sprayers = 0.06 m³ spray/m² breached air
    \(C_{\text{inhaled}}\): a.s. conc. in breathing zone (mg a.s./m³)
    \(C_{\text{spray}}\): a.s. conc. in spray solution (mg a.s./m³)
    \(IR\): Inhalation rate (m³/hr)
    \(T\): Duration of exposure (h/d)
  - **Based on operator inhalation**
    \[
    I = \frac{I_{\text{app}} \times \text{WR} \times \text{AR}}{\text{WR} \times \text{ST}}
    \]
    \(I_{\text{app}}\): applicator respiratory exposure (mg/kg a.s.)
    \(AR\): application rate (kg a.s./ha)
    \(WR\): work rate (ha/day)
    \(ST\): spraying time (min/ha); exposure during 1 min

- **Total exposure (mg a.s./person/day) and risk index**
  \[
  IE_{\text{bystander}} = \frac{DE \times Ab_{\text{d}}}{{B/W}} \quad RI_{\text{bystander}} = \frac{IE_{\text{bystander}}}{\text{AOEL}}
  \]
  \(DE\): dermal exposure (mg a.s./person/day)
  \(Ab_{\text{d}}\): dermal absorption factor
  \(B/W\): body weight (default: 70 kg)
  \(AOEL\): Acceptable Operator Exposure Level (mg/kg bw/day)

- **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)
Resident Indicator

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

\[
DE_{\text{dermal}} = \frac{DE_{\text{acute}} \times N_{\text{events}}}{AT} = \frac{DE_{\text{acute}} \times RD}{AT}
\]

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

\[
I_{\text{chronic}} = C_{\text{air}} \times IR \times 10^3 \times \frac{\text{DED} \times RD}{AT}
\]

DE_{\text{dermal}}: chronic resident dermal exposure (mg/person/day)
DE_{\text{acute}}: acute resident dermal exposure (mg/person/day)
I_{\text{chronic}}: chronic resident inhalation exposure (mg/person/day)
C_{\text{air}}: TWA concentration of the pesticide in the air (g a.s./m³)
IR: inhalation rate (m³ air/hr) (default: 0.62 m³/hr)
DED: daily exposure duration (hr/d)
N_{\text{events}}: number of exposure events (-)
RD: resident days (d)
AT: averaging time (d); yearly averaged chronic dose; AT = 365 d

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

\[
\bar{C}_{gh, \text{ex}, \text{air}, i} = \left( \frac{\bar{C}_{gh, \text{max}, \text{air}, \text{ref}}}{\Delta_{gh, \text{ref}}} \right) \left( \frac{k_{gh, \text{vent}}}{k_{gh, \text{vent}} + k_{gh, \text{dep}}} \right) \left( \frac{T}{T + k_{gh}} \right) \left( \frac{\bar{V}_{gh}}{V_{gh}} \right)
\]

- \(I = C_{gh, \text{ex}, \text{air}, \text{ref}} \times IR \times 10^{-3} \times \text{DED}\)

- \(\bar{C}_{gh, \text{max}, \text{air}, \text{ref}}\): gas-phase conc. in leeward side up to 20 m (\(\mu g/m^3\))
- \(\bar{C}_{gh, \text{max}, \text{air}, \text{ref}}\): gas-phase conc. in greenhouse over \(T\) (s) (\(\mu g/m^3\))
- \(k_{gh, \text{dep}}\): dep. vent. rate constant in greenhouse (s\(^{-1}\))
- \(k_{gh, \text{vent}}\): vent. rate constant in greenhouse (s\(^{-1}\))
- \(T\): time over which exposure is integrated (s)
- \(V_{gh}\): Volume greenhouse (m\(^3\)) (default: 45,000 m\(^3\))
- \(A_{gh, \text{front, int}}\): surface area façade on the wind direction (m\(^2\)) (450 m\(^2\))
- \(K_{gh}\): medium parameter (-) (default: 0.5)
- \(\bar{U}\): wind velocity just above the roof (m/s) (arbitrary value of 3 m/s)
- \(I\): inhalation rate (mg/day)
- \(IR\): Inhalation rate (m\(^3\)/hr)
- \(\text{DED}\): daily exposure duration (hr/day)

## Sensitive population groups

### 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 (m\(^3\)/hr)
  - \(BW\): body weight (kg)
  - \(EA\): exposed area (m\(^2\)/d)
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

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
**Aggregate and Cumulative Risk Assessment**

1. **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

---

**Aggregate and Cumulative Risk Assessment**

- **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
Validation of indicators
HAIR WP13

Peter Borgen Sørensen
Christian Damgaard
Jørgen Axelsen

National Environmental Research Institute
Department of Terrestrial Ecology
Silkeborg, Denmark

A risk indicator is a assumed correlation between the known indicator and the unknown risk
Real validation is difficult II

Validation of exposure related to emission using monitoring data

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<tr>
<th>Id</th>
<th>Substances</th>
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<th>Predicting variables Set 2</th>
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</tr>
</tbody>
</table>
For terrestrial plant indicator: Based only on glyphosate, it was not possible to falsify the indicator.
Ordinal verification

Two conditions:

\[(I_1^1, I_2^1)\]
\[(I_1^2, I_2^2)\]

If both Indicator 1 and 2 are valid:

\[I_2^2 > I_1^1 \iff I_2^1 > I_1^2\]

The runoff exposure indicator

\[C_{2w} = C_{\text{drift}} + (L_{\text{runoff}} + L_{\text{drainage}} + L_{\text{erosion}}) \cdot e^{\frac{\ln 2}{DT_{\text{water},s}}} \cdot \frac{d \cdot 0.1}{w \cdot d - d^2}\]

Neglecting: Drainage, Erosion and temporal changes...
Test for relative separation only due to differences between the chemical properties and application rate between two active ingredients:

- **Env.**: Environmental conditions like length, 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
\[ C_{w} = C_{dry}(AR, Tech, Env) \cdot \left[ L_{\text{max}}(AR, Chem, Env) \right] \cdot \frac{d \cdot 0.1}{w \cdot d}\]

where

\[ L_{\text{max}} = \phi R \cdot \frac{\frac{\text{max}}{\text{max}}}{1 + K_{d}} \cdot f_{1}, f_{1} \]

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

\[ \frac{AR}{1 + K_{d}} : \frac{AR}{Chem} \]

**Ordinal verification**

Time scale: Worst case short after application (t \( \approx \) DT50)

Test: relative separation of active ingredients

Risk rank

Pest1\(^1\), Pest2\(^1\) → Indicator → Pest2\(^2\) → Pest1\(^1\)

*Increase in complexity has the burden of proof*
Two models M1 and M2, where M1 is completely included in M2 and thus M2 more complex than M1:

\[ M1: AR \quad \text{and} \quad M2: AR/(1+Kd) \]

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”

---

**Data from Danish EPA**

<table>
<thead>
<tr>
<th>Id</th>
<th>Name</th>
<th>AR (g/ha)</th>
<th>Kd (l/kg)</th>
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<tbody>
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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:

$$AR_A < AR_B \text{ and } AR_A / (1 + K_{d,\text{mean},A}) > AR_B / (1 + K_{d,\text{mean},B})$$
Total number of rankings: $58 \cdot 57/2 = 1653$

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*
The $K_d$ is not without uncertainty
For two substances (A and B)

Sørensen et al. 2005

Set A>B if and only if:
\[ AR_A < AR_E \text{ and } AR_A/(1+K_{d,max,A}) > AR_B/(1+K_{d,min,B}) \]

Higher rank: AR(1+K_d)

Set A<B if and only if:
\[ AR_A > AR_E \text{ and } AR_A/(1+K_{d,min,A}) < AR_B/(1+K_{d,max,B}) \]

Higher rank: AR(1+K_d)
The selectivity of using $AR/(1+Kd)$ instead of $AR$
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 could be considered as replacement of single substance calculations
- The complexity of the indicator difficult to validate
HAIR
Risk aggregation
Juan Piñeros Garcet, Vincent Van Bol, Luc Pussemier, W. Steurbaut

VAR (CODA - CERVA)
UGent
www.var.fgov.be

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
Risk events aggregation: probabilistic

Aggregation levels graph

C: environmental compartment
A: active substance
S: space
T: time
H: hazard
HAIR Maximal and minimal aggregation level

Risk events distribution

\[
RiskFrequency = \frac{\# \ of \ risk \ events}{total \ # \ of \ risk \ events} = \int \left( \frac{sales}{dose} \right) dy
\]

RiskIndex = \frac{EXP}{TOX}
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
Wallonia:
10 agricultural regions

1 agricultural region

municipality

1 ha
Compare regions, identify priorities

Limoncuse region

$\mu = 2.8$
$P_{50} = 0.08$
$P_{90} = 1.06$
$P_{95} = 4.65$

Ardennes region

$\mu = 0.3$
$P_{50} = 0.005$
$P_{90} = 0.04$
$P_{95} = 0.13$

$RI = \frac{AR_{\text{survey}} (\text{kg/ha})}{LD_{50} (\mu g/l)}$

Cumulative frequency: see groups of regions

$
i$ proportion $\leq RI$

KI
Generate maps of risk percentiles

D) Implementation in the HAIR software
Aggregation question definition
harmonised environmental indicators for pesticide risk

break-down options

Adverse Dilemmas
- name (farm or all together)
- group of a.s.
- single a.s.

Crop
- name (farm or all together)
- Crop
- Product group

Task
- name (farm or all together)
- County/Department/Province/Year/ID

Time
- name (farm or all together)
- long term
- very year
Aggregation statistics and maps

Indicator: Emission-Drift (x1000)
distribution statistics per Crop, "County/Department/Province (NUTS2)"

<table>
<thead>
<tr>
<th>Crop</th>
<th>County/Department/Province (NUTS2)</th>
<th>mean</th>
<th>p0.05</th>
<th>p0.10</th>
<th>p0.25</th>
<th>p0.50</th>
<th>p0.75</th>
<th>p0.90</th>
<th>p0.95</th>
<th>p0.99</th>
<th>1st Highest according to mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter bar</td>
<td>East Wales</td>
<td>2.53</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.59</td>
<td>1.00</td>
<td>1.50</td>
<td>2.00</td>
</tr>
<tr>
<td>Winter bar</td>
<td>West Wales and The Valleys</td>
<td>2.53</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.59</td>
<td>1.00</td>
<td>1.50</td>
<td>2.00</td>
<td>2.50</td>
</tr>
<tr>
<td>Spring bar</td>
<td>East Wales</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.50</td>
<td>1.00</td>
<td>1.50</td>
<td>2.00</td>
<td>2.50</td>
<td>3.00</td>
</tr>
<tr>
<td>Spring bar</td>
<td>West Wales and The Valleys</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.50</td>
<td>1.09</td>
<td>1.50</td>
<td>2.00</td>
<td>2.50</td>
<td>3.00</td>
</tr>
<tr>
<td>Oats</td>
<td>East Wales</td>
<td>13.20</td>
<td>6.00</td>
<td>13.00</td>
<td>13.00</td>
<td>13.09</td>
<td>13.00</td>
<td>13.00</td>
<td>13.00</td>
<td>13.00</td>
<td>13.00</td>
</tr>
<tr>
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<td>West Wales and The Valleys</td>
<td>13.20</td>
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<td>13.00</td>
<td>13.00</td>
<td>13.09</td>
<td>13.00</td>
<td>13.00</td>
<td>13.00</td>
<td>13.00</td>
<td>13.00</td>
</tr>
</tbody>
</table>

* Source indicators: same as "Nuisance"