Pesticide impacts on water systems during a 10 year period – based on pesticide usage data in Finland

Workshop of
Pesticide fate in soil and water in the northern zone
3.-4.9.2014 Bioforsk, Ås, Norway

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Agenda

- Introduction (5)
- Material and methods (2)
- Results (3)
- Conclusions (1)

Introduction

Introduction: Finland

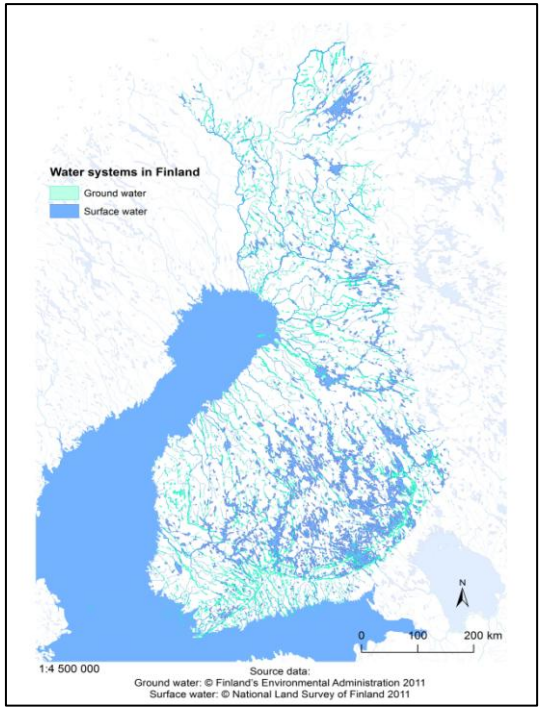


Figure. The land of the thousand lakes. Surface and ground water systems in Finland. (Map made by Eeva Lehtonen, MTT)

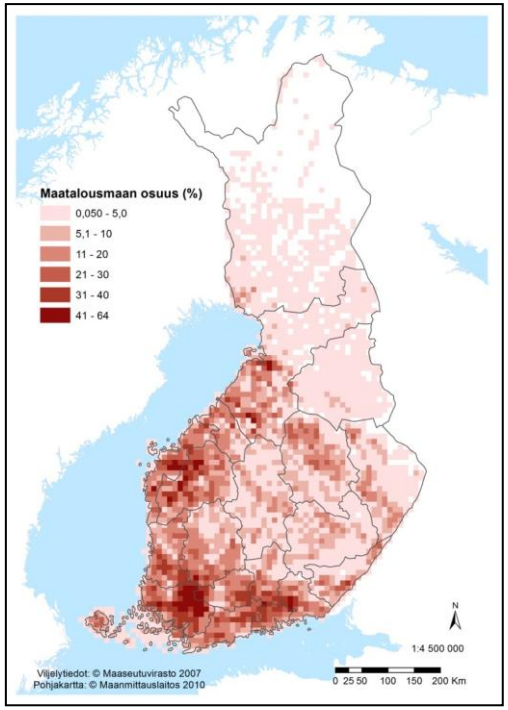


Figure. Agricultural land in Finland. (Map made by Eeva Lehtonen, MTT.)

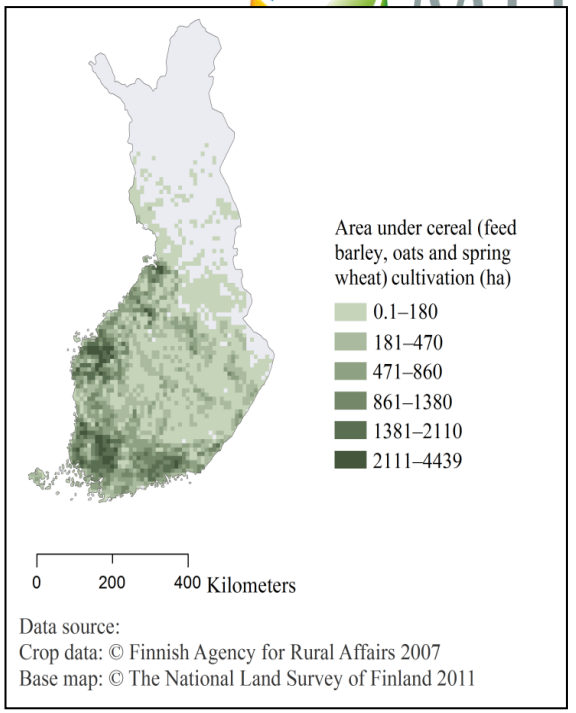


Figure. Feed barley, spring wheat and oats cover about 50 % of the total cultivated crop area in Finland. (Map made by Riikka Nousiainen, MTT.)

Year 2012	Area (ha)	From the total area of Finland (%)
Finland	39 090 300	100
Total land	30 389 300	77.8
Forests	23 000 000	59
Total arable and horticultural land	2 300 000	5.9
Plant cultivation	1 282 818	3.3
Organic cultivation	205 000	0.5
Fresh water	3 453 900	9
Sea water	5 247 100	13.4

Introduction:
Pesticide sales in Finland

- Finnish Safety and Chemicals Agency (TUKES) does risk assessment, approves pesticides and sets risk mitigation methods. It also collects the sales data in Finland.
- In 2011
  - Total sales of active ingredients 1707.5 tonnes
  - 354 plant protection products
  - 154 active ingredients
  - ➢ Usage on whole agricultural land 0.7 kg/ha

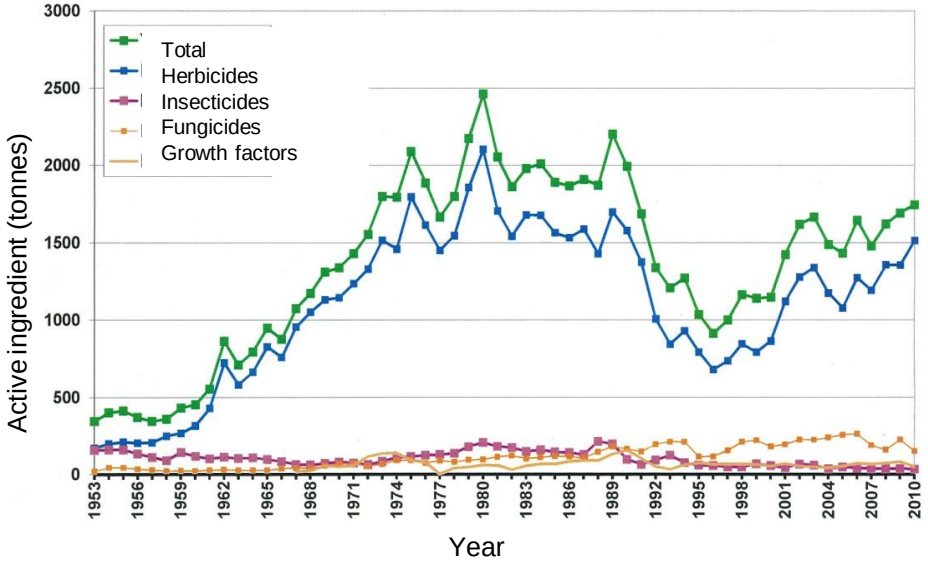


Figure. Pesticide sales in Finland over 1953-2010 (TUKES)

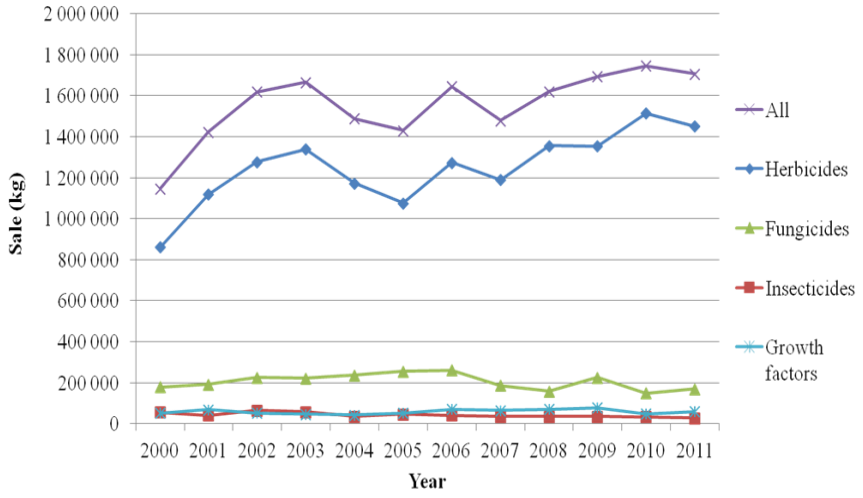
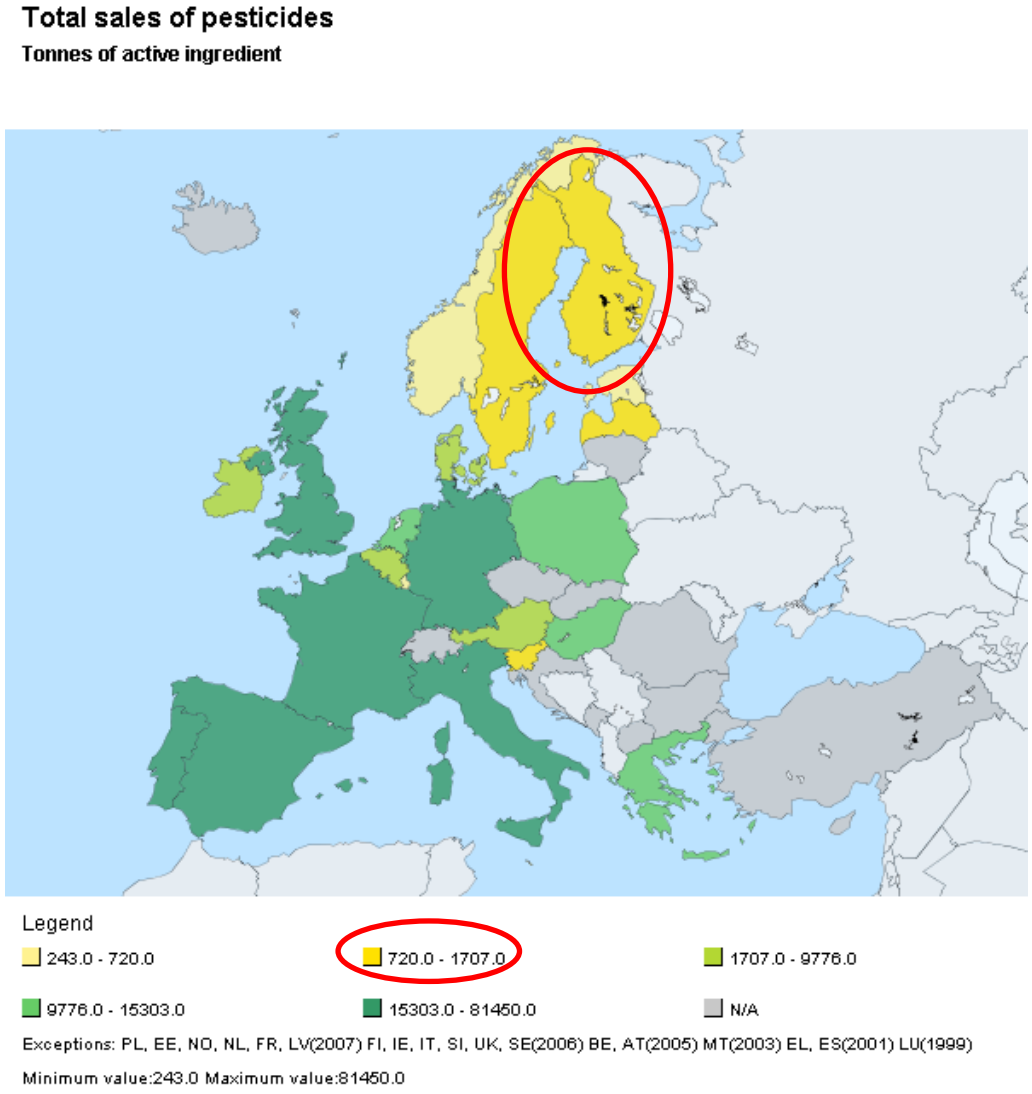


Figure. Sales data of agricultural plant protection products in Finland 2000-2011. Total sales was in average 1 610 134,7 kg per year and includes about 180 different actice ingredients).

Introduction: Pesticide sales in EU



Introduction: Pesticide usage data

- **Pesticide usage data**
  - To collect regularly the data of pesticide usage on target plants is rather new action in EU (1185/2009/EC).
    - In Finland TIKE (Agricultural Statistics) will collect the data
  - E.g. Finnish Advisory Centres have collected usage data for their own purposes

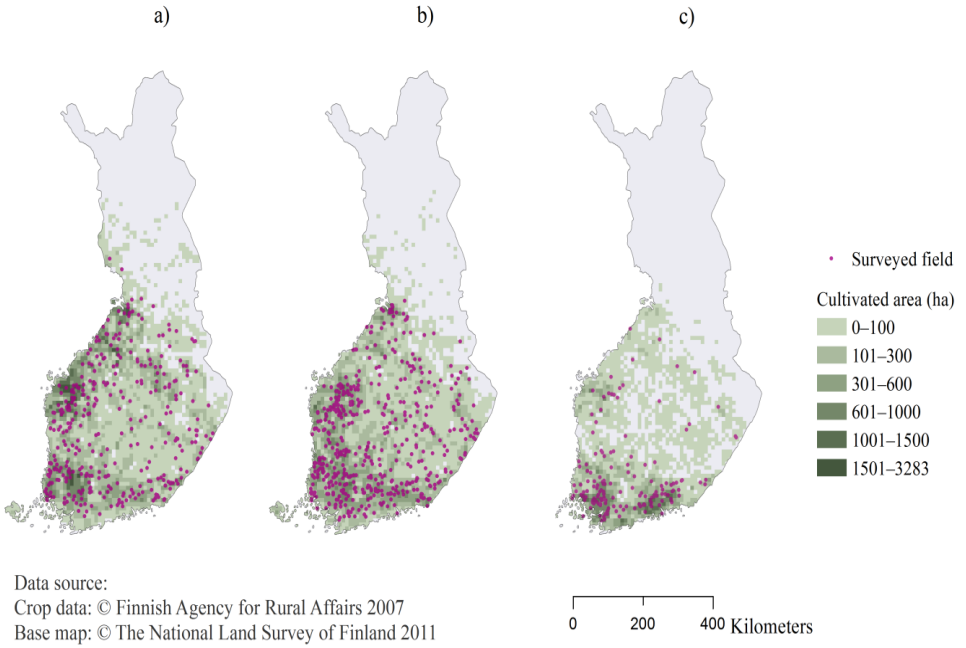


Figure. Pesticide usage of a case data in 2007 in Finland. Pesticide usage on cereal fields (purple dots) of a) feed barley (471 fields), b) oats (500 fields) and c) spring wheat (157 fields) (total 1,128 fields ha).

Pesticide usage on cereals in Finland 2007

Introduction: Ecotoxicity impact assessment

- **Ecotoxicity impact assessment**
  - The potential ecotoxic impacts of pesticide emissions can be evaluated in LCA (life cycle assessment).
  - Can be used as a tool to compare impacts of different chemicals, e.g. active ingredients of plant protection products (=PPP).
  - E.g. UsetoxTM -model

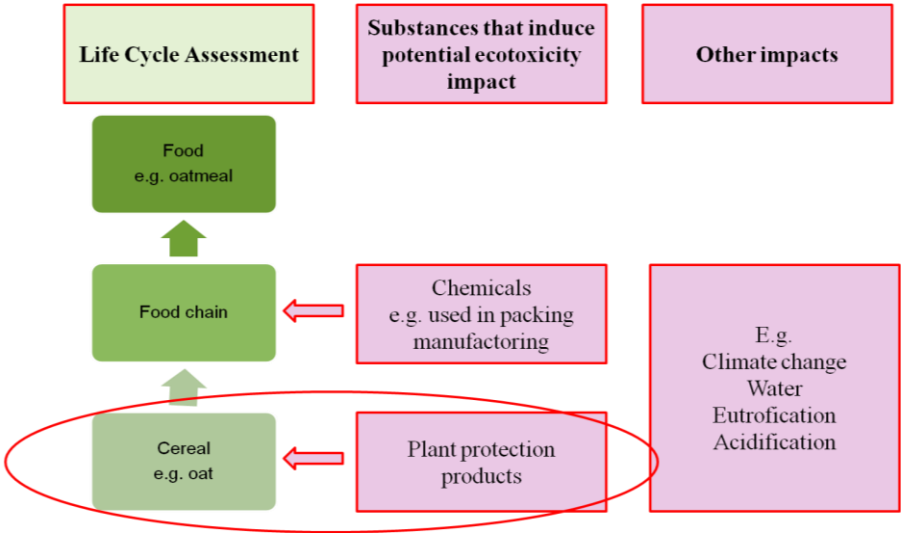


Figure. Forming of potential ecotoxicity in life cycle assessment. Circle illustrates the substance of our study.

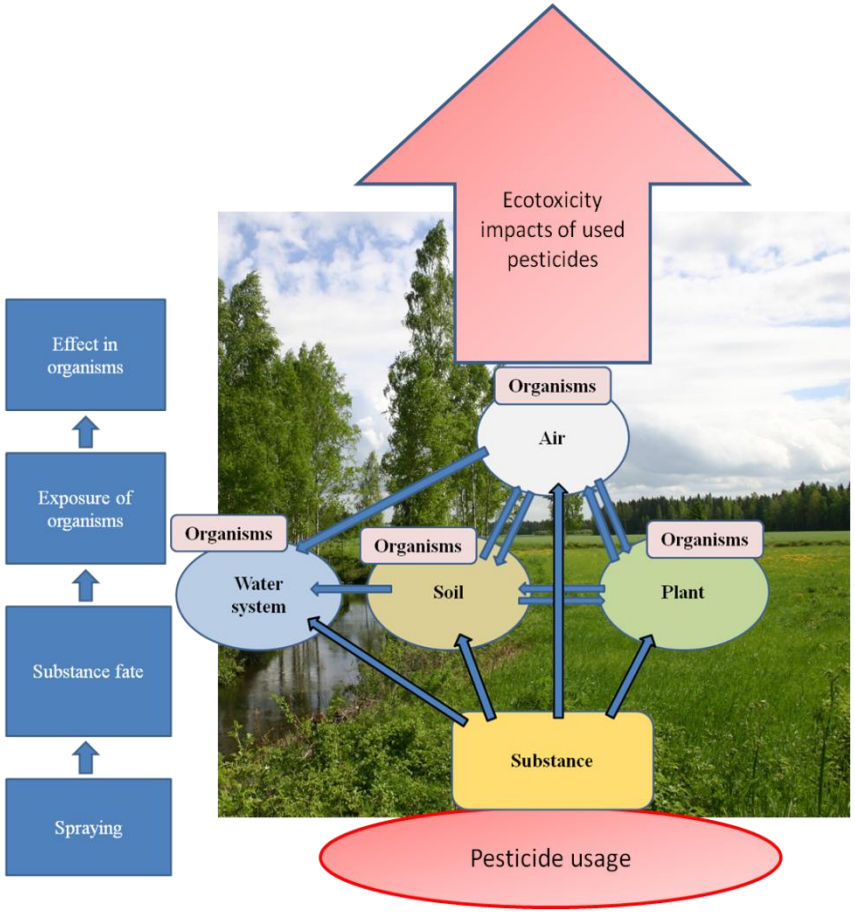
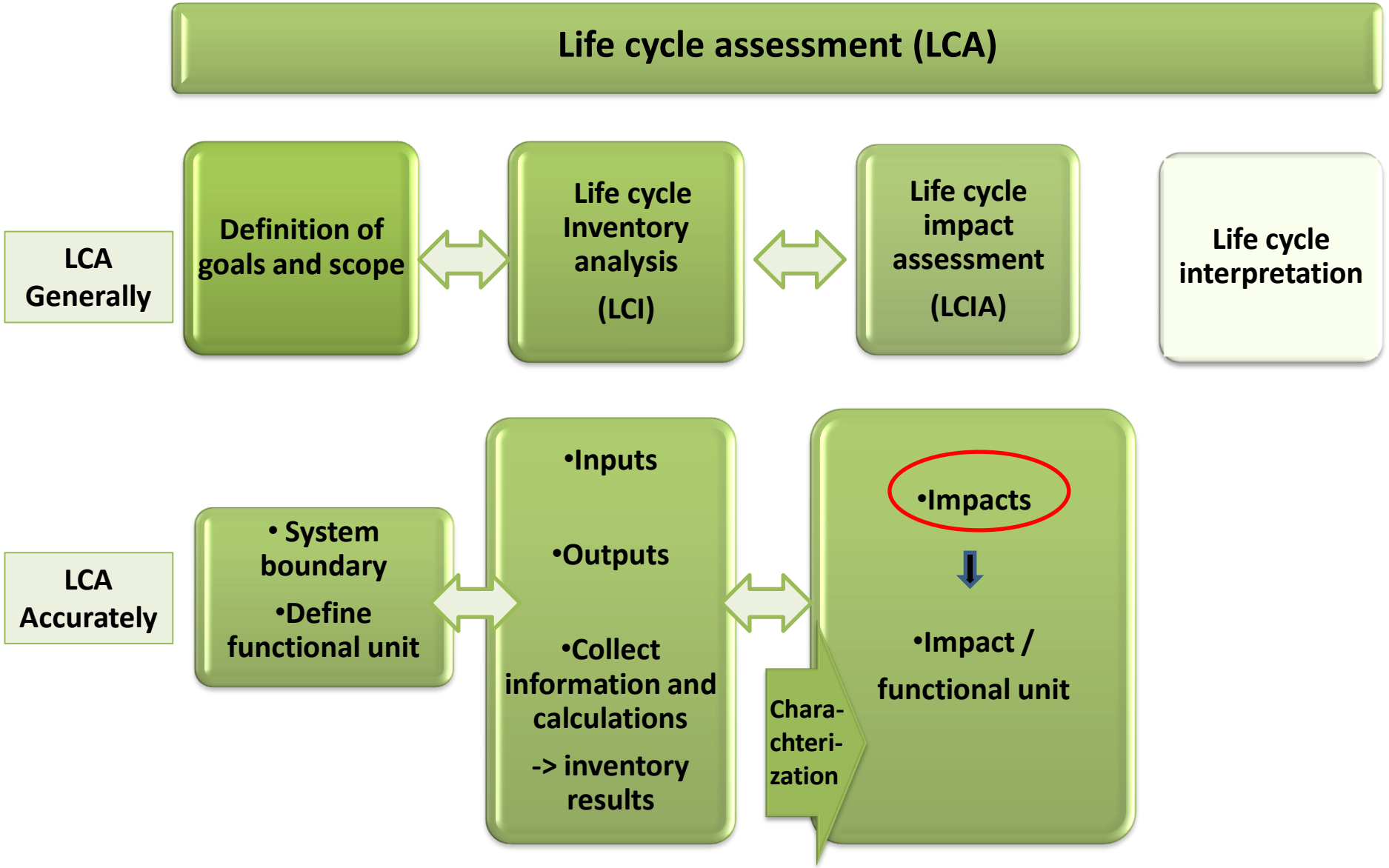


Figure. The potential ecotoxic impacts of pesticide emissions can be evaluated in LCA by modelling the fate of active ingredient in air, water, and soil and their exposure and effects on organisms.


Life cycle assessment (LCA)
LCA Generally
Definition of goals and scope
Life cycle Inventory analysis (LCI)
Life cycle impact assessment (LCIA)
Life cycle interpretation
LCA Accurately
• System boundary
•Define functional unit
•Inputs
•Outputs
•Collect information and calculations
-> inventory results
Chara-chteri-zation
•Impacts
•Impact / functional unit

M&M

Material and methods

- **Pesticide usage data**
  - Received from the Pro Agria Advisory Centres.
  - Obtained from Finnish crop production fields over 2002-2011.
  - Covered about 0,5 % from the total sales amount per year in Finland. The usage data corresponds to the sales (R-value 0.955).
  - Included 107 active ingredients (about 180 different active ingredients sold in Finland over 2002-2011).

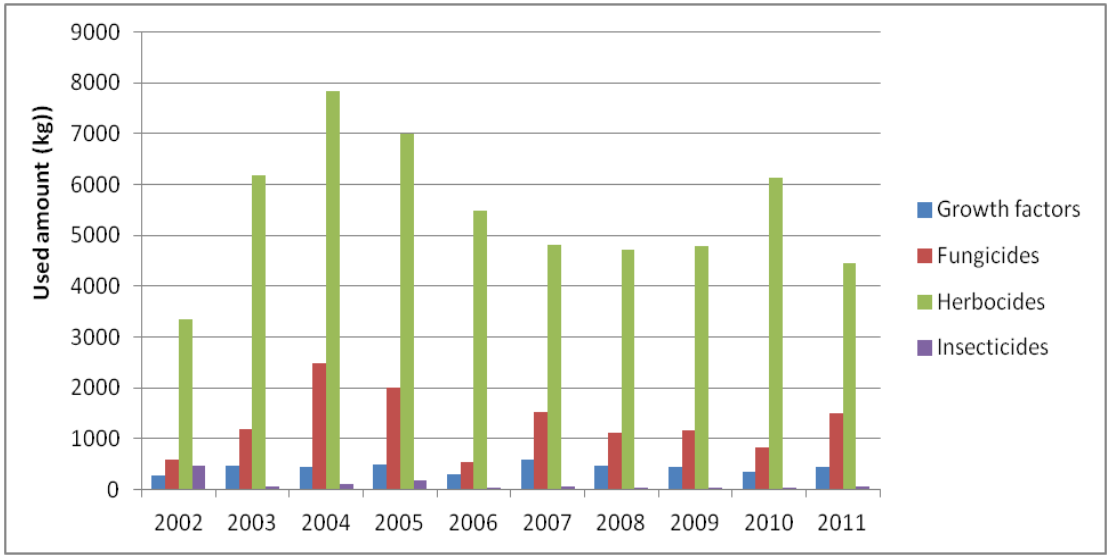


Figure. Pesticide usage data was kindly obtained from Pro Agria Advisory Centres in Finland.

Material and methods

- **Models to calculate potential ecotoxicity impacts**
  - SETAC consensus LCIA model USEtox™ (version 1.01) (Rosenbaum et al. 2008, UsetoxTM 2013) were used to calculate characterization factors. The model was customized to fit Finnish regional environmental conditions by obtaining the relevant parameters from GIS.
  - PestLCI 2.0 (Dijkman et al. 2012) was used to model emission fate assuming average Finnish field conditions.
  - Total 54 characterization factors were used for the impact calculations (from the total of 107 active ingredients used).

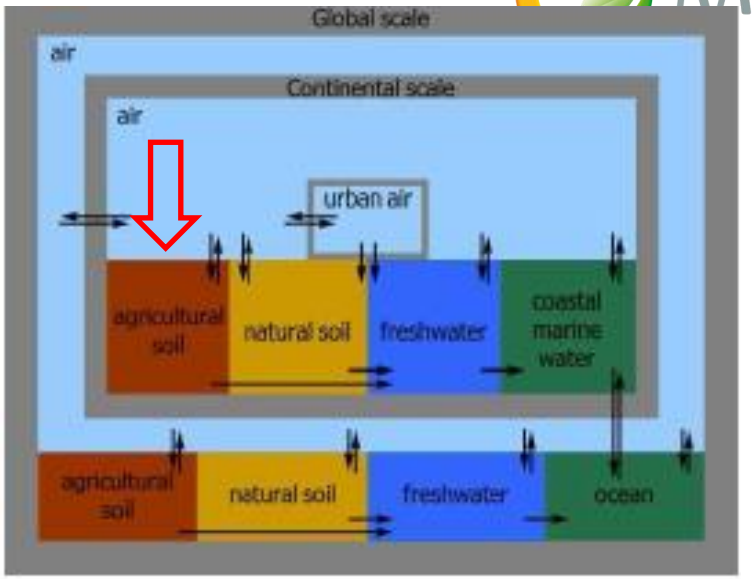


Figure. USEtox structure. USEtox is officially endorsed by the UNEP/SETAC Life Cycle Initiative, recommended in the ILCD Handbook for assessing toxicity in life cycle impact assessment (JRC-IES, 2011). It is also used by the US EPA for risk priorization (e.g. Mitchell et al. 2013) and is applied in more than 200 LCA and comparative risk assessment studies (USEtox™, 2013).

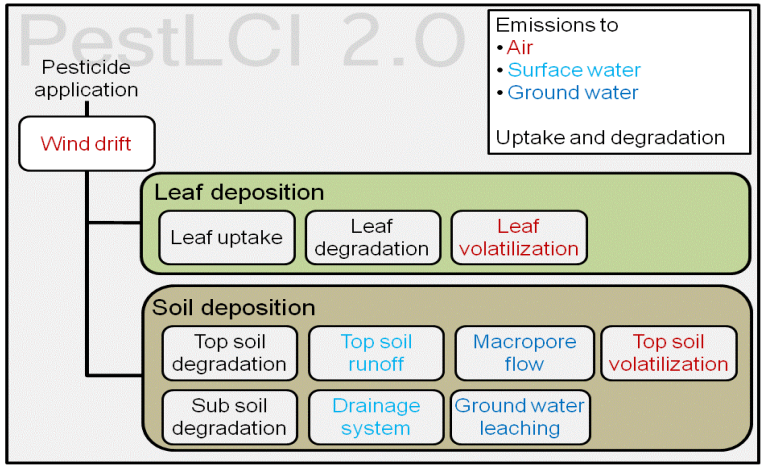


Figure. PestLCI 2.0

Results

Results

- Total amount of used pesticides was 6439,3 kg in 2011 and 7291,9 kg in average per year over 2002-2011.
- Characterized pesticides induced potential ecotoxicity of 503 703 CTUs in 2011 and 466 770 CTUs in average per year over 2002-2011.
- The main contributors to the total potential ecotoxic impact were fungicides (over 85 % from the total ecotoxicity, even though they used amount was 23 % from the total).
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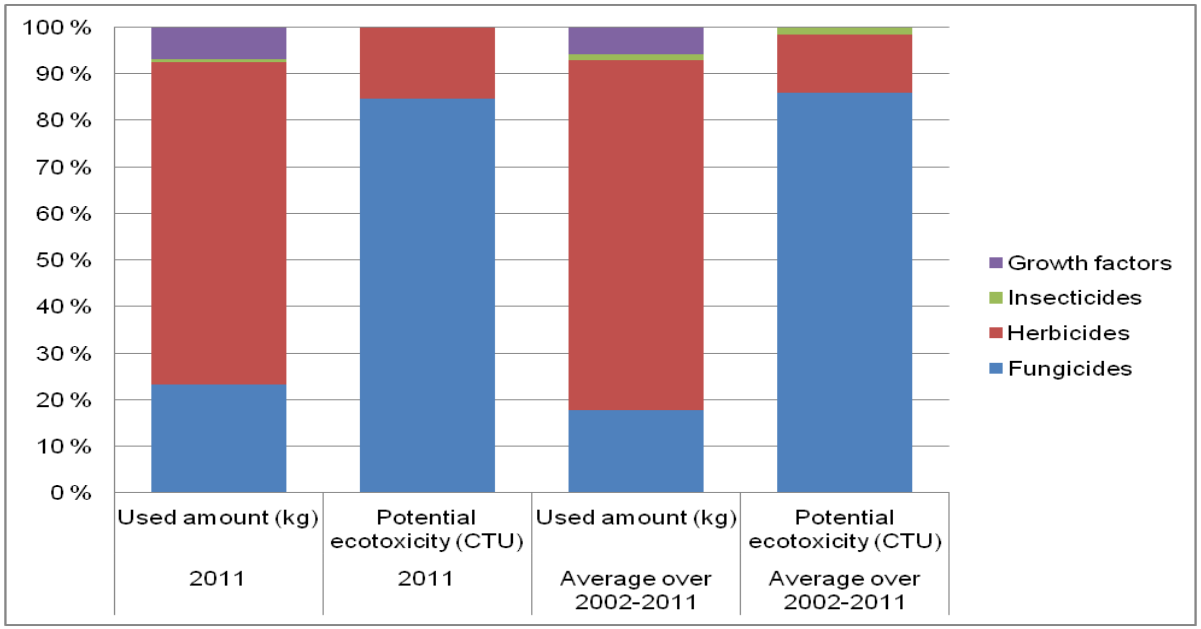

Figure. Pesticide substance groups in order to affect ecotoxicity pressure and their used amount (%) in 2011 and in average impacts per year over 2002-2011 in Finland.

Results

- The total ecotoxicity varies over time period depending on the quantity and quality of used pesticides.
- Single very hazardous substances had a strong increasing effect on the total impact.

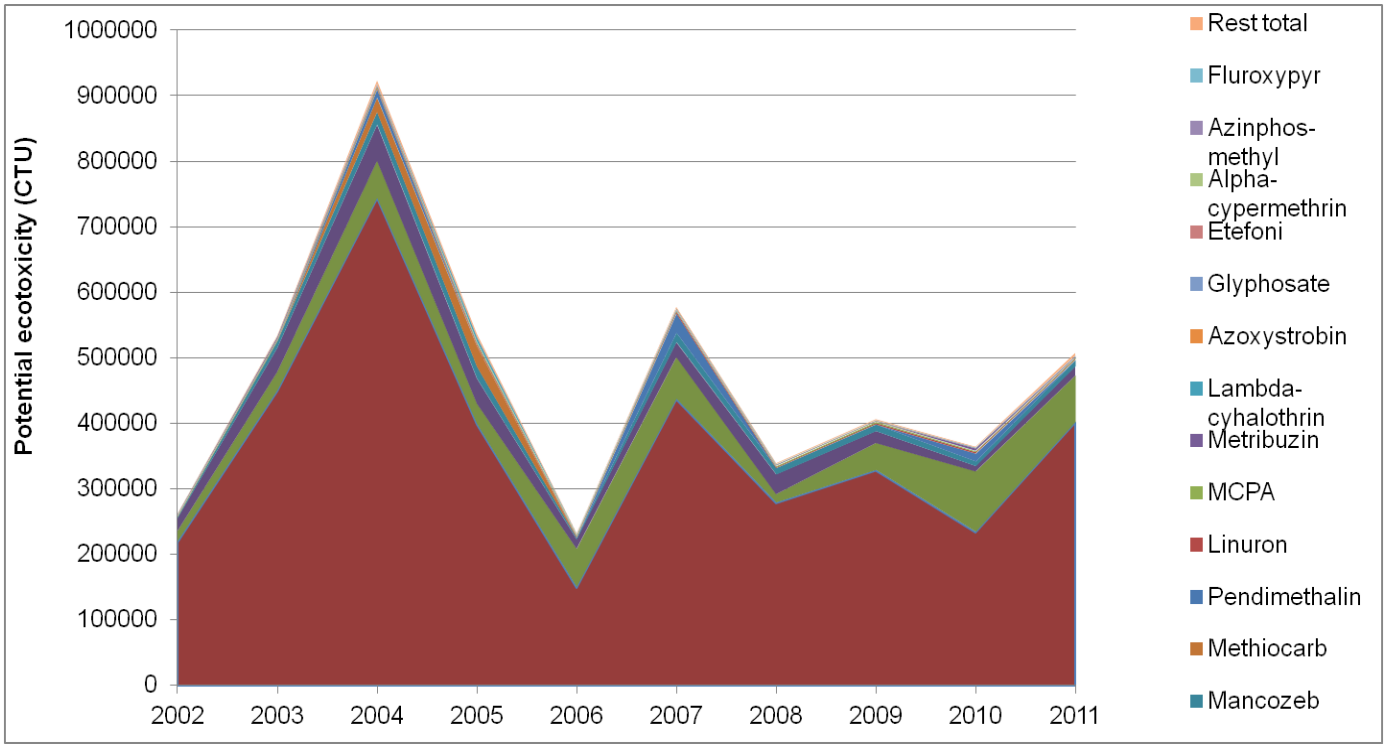

Figure. Potential ecotoxicity (in CTUs) for pesticides sold in Finland over 2002-2011. Rest means other characterized substances than these 16 substances.

Results

- The most of the impacts induced fungicide
  - fungicide fluazinam (used on potato),
  - herbicide aclonifen (e.g.peas,carrot,onion),
  - fungicide prochloraz (cereals, oil seeds)
  - fungicide mancozeb (on potato), respectively.

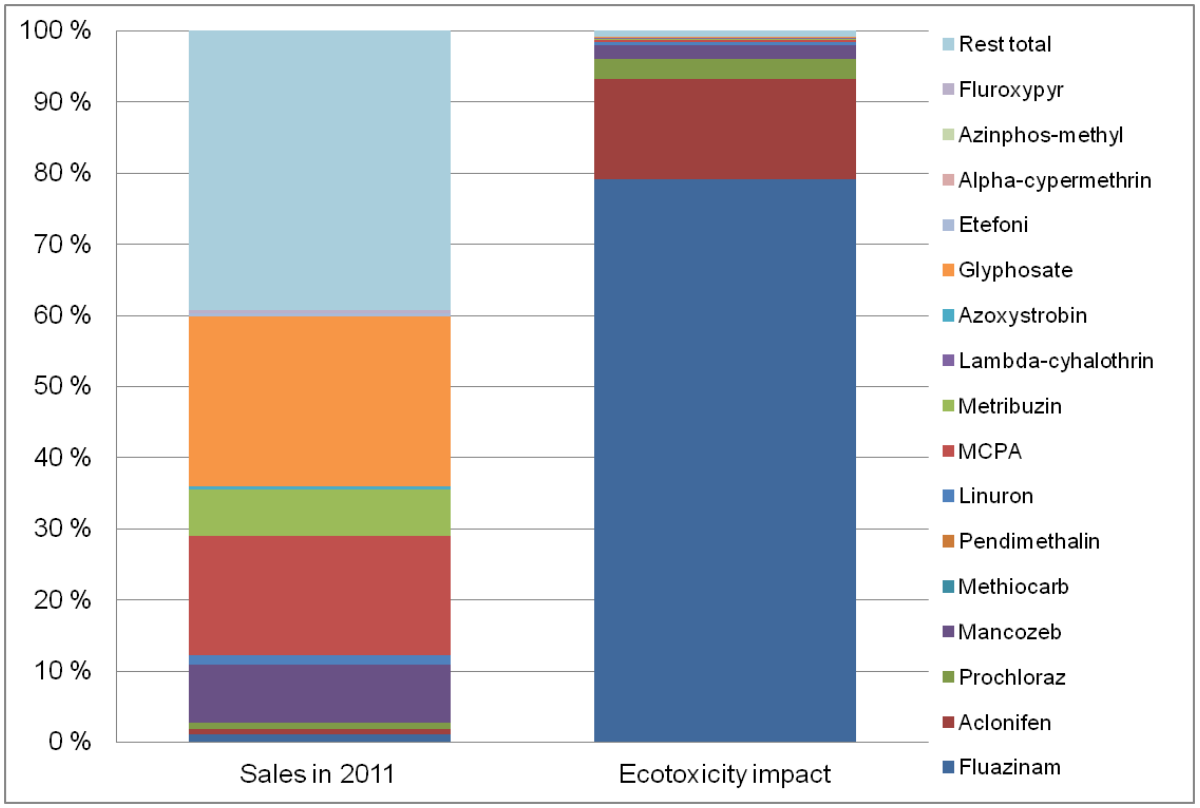

Figure. Potential ecotoxicity (in CTUs) vs. sales of pesticides in Finland In 2011. Rest means other characterized substances than these 16 substances.

Conclusions

Conclusions

- Pesticide usage data on target crops is needed to assess risks on national scale; it describes better the impacts or risks of pesticides than only sales data.
- Approach of ecotoxicity impact assessment enables to make changes in environmental management towards to sustainable plant protection; to change chemicals to more environmental safe ones.
  - In the EU strategy the aim is to reduce risks of used pesticides to a minimum (2009/128/EC) via IPM (intregrated pest management)
  - IPM development is also needed to be measured
  - Could this approach be also used as a part of risk assessment of pesticides or be a handy tool for farmers?

Thank you!

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