Probabilistic risk assessment of pesticides under present and future agricultural and climate scenarios using a Bayesian Network: A Northern European case study

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Purpose

- Integrating future change scenarios
  - Climate
  - Application of pesticides
  - Crop use
- Site specific exposure e.g. soil

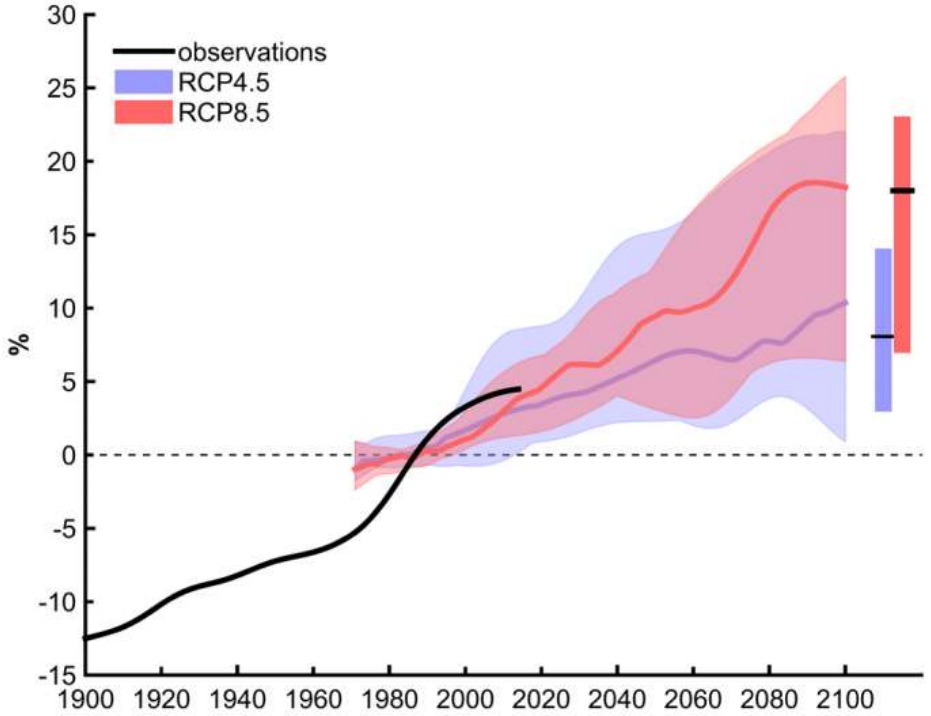
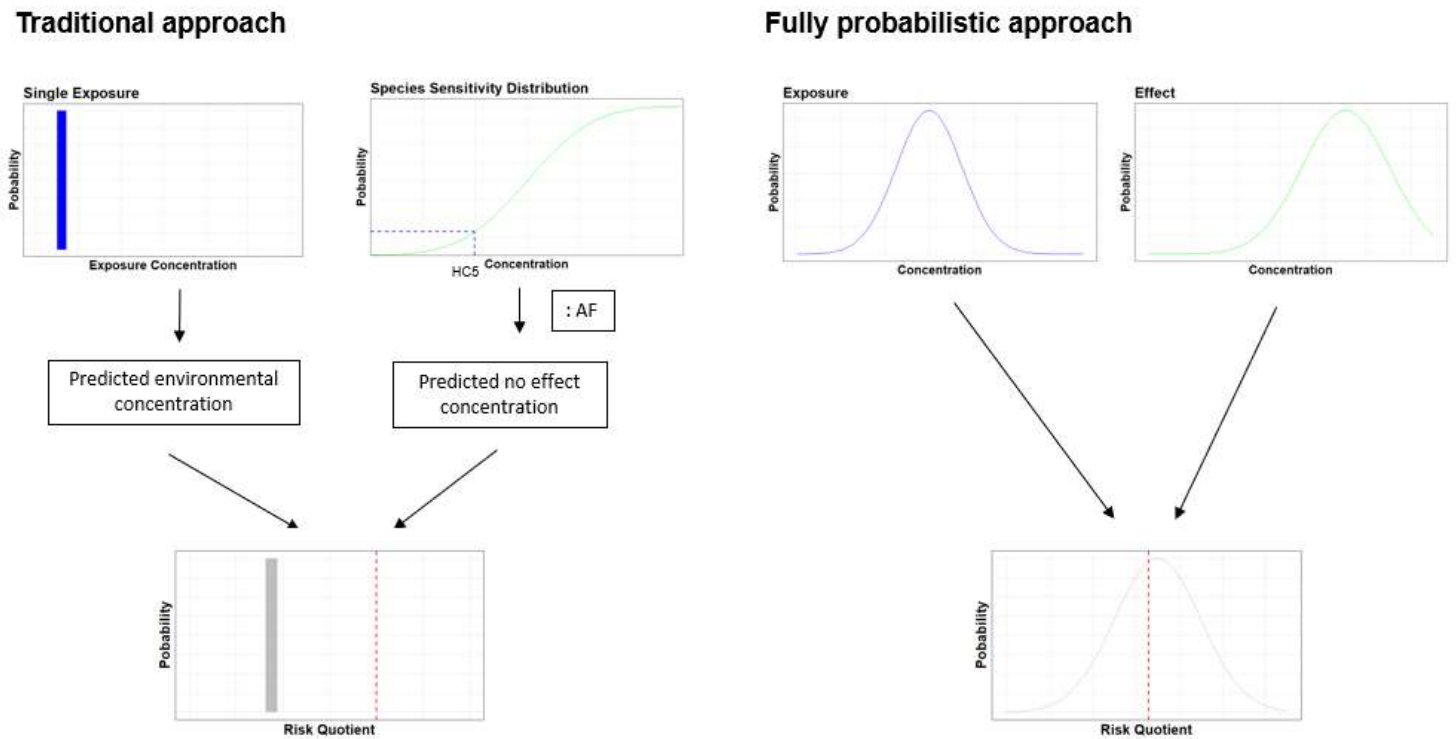


Figure 3.10 Annual precipitation over Norway as deviation (%) from the period 1971-2000. Black curve represents observations (1900-2014), red and blue curved lines show median values for the ensemble of ten RCM simulations for emission scenarios RCP8.5 and RCP4.5. All curves are smoothed. Shading indicates the spread between low and high climate simulation (10th and 90th-percentile). The box plot on the right shows projections up to 2071-2100 for both scenarios.

https://www.miljodirektoratet.no/globalassets/publikasjoner/M741/M741.pdf

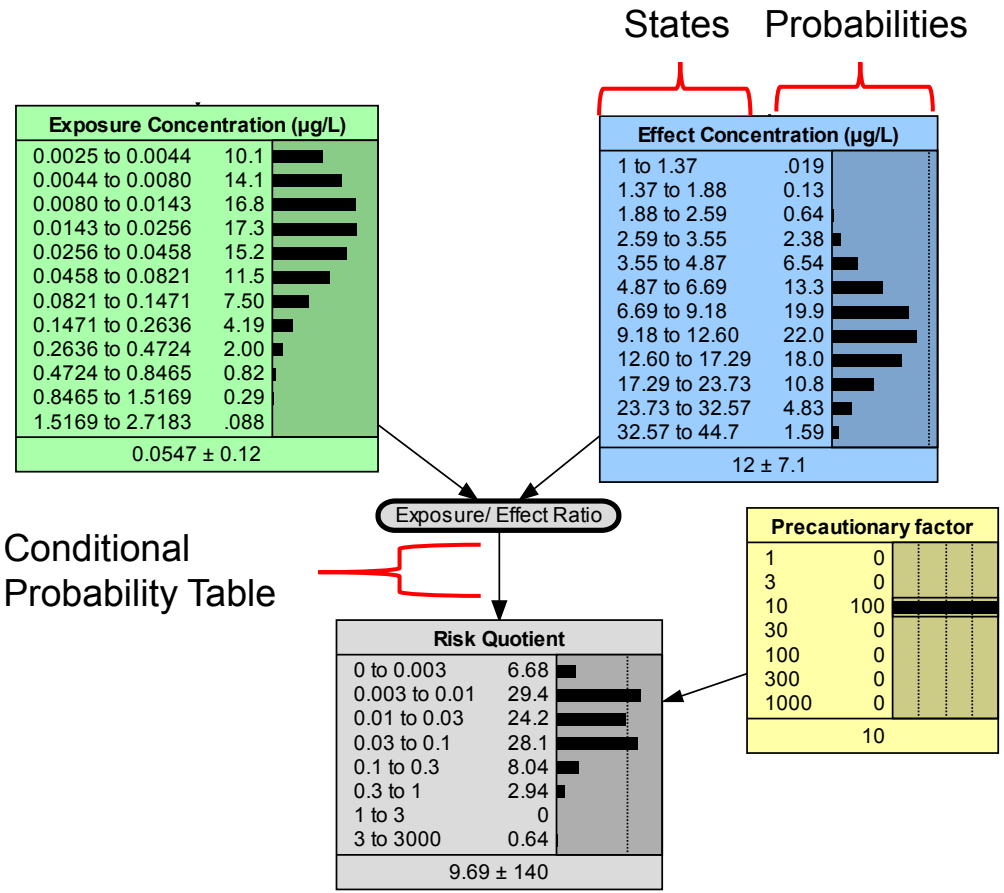
Approaches for risk characterization



For more information:
Mentzel et al. (2021)
DOI: 10.1002/ieam.4533

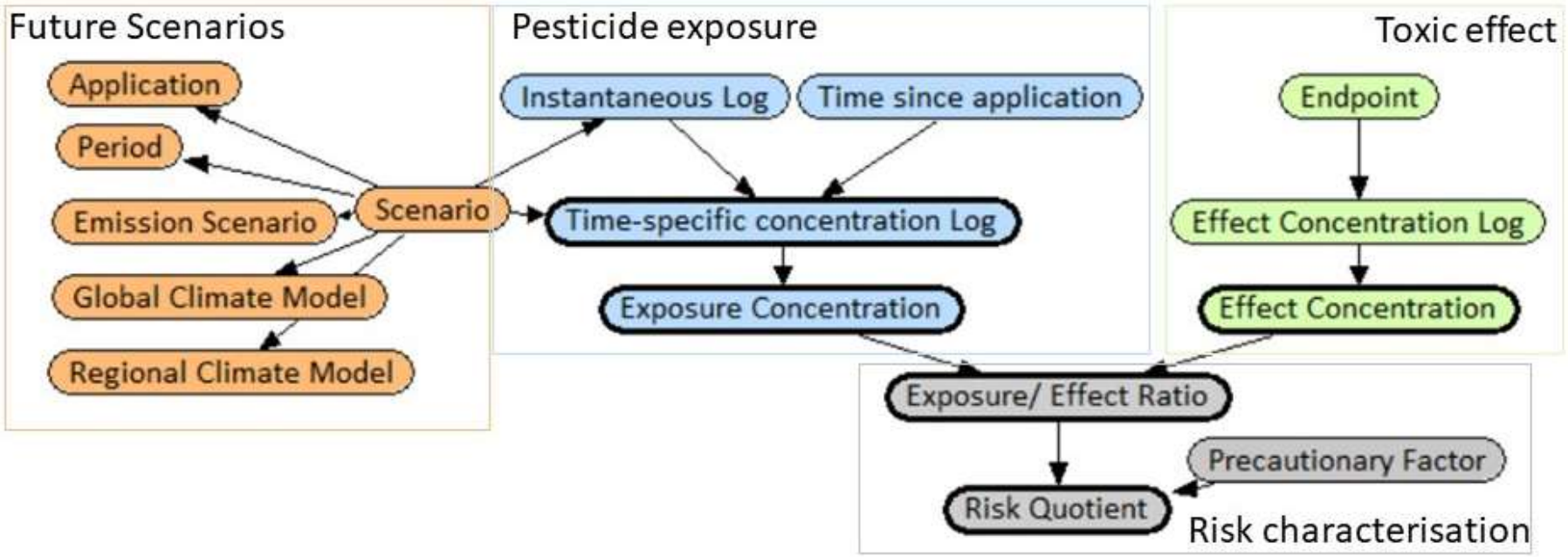
Bayesian Networks

- Probabilistic graphical model
- Probability of given state
- Bayes' theorem
- Meta-models



Example for BN by *Mentzel et al. (2021)*: DOI: 10.1002/ieam.4533

Concept for the Bayesian Network



Pesticide fate and transport model

World Integrated System for Pesticide Exposure (WISPE)

Crops scenarios

Winter cereals

Application Scenarios

Baseline &
+/- 50%

Climate model

Climate model 1:
HADCM3-Q0 A1B SMHI RCA3
Climate model 2:
ECHAM5-r3 A1B SMHI RCA3

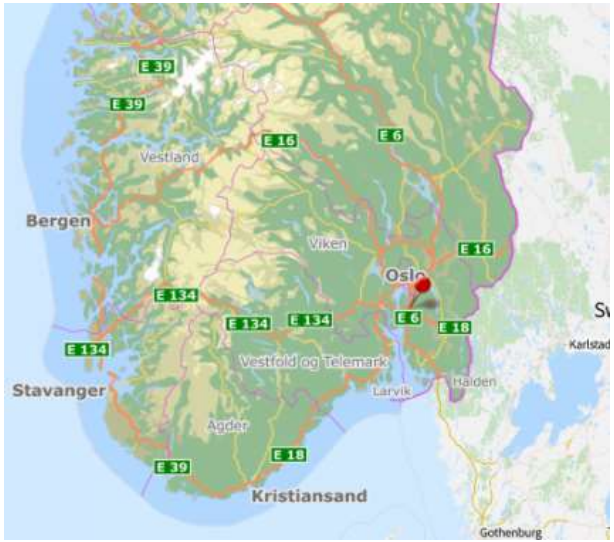
Soil scenarios

Loam

Bolli, R.I. et al. (2013)

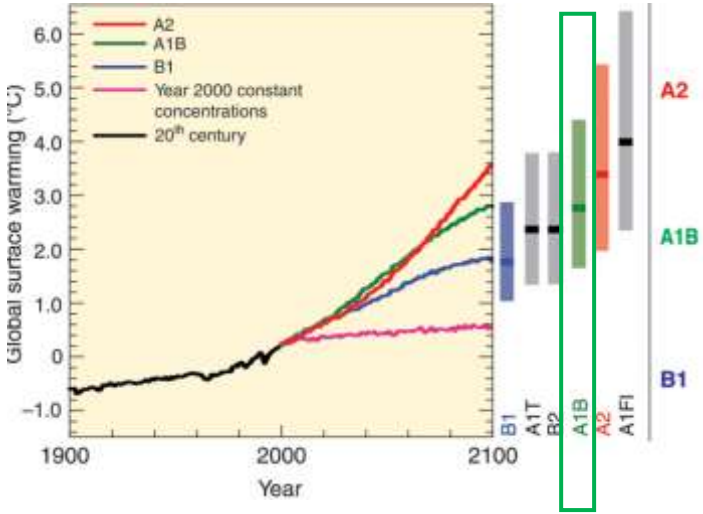
WISPE model input and assumptions

Case study area - Syverud



https://commons.wikimedia.org/wiki/File:Europe-Norway_(orthographic_projection).svg

Climate models



Kjellström et al. 2010.
21st century changes in the European climate: uncertainties derived from an ensemble of regional climate model simulations.
https://onlinelibrary.wiley.com/doi/epdf/10.1111/j.1600-0870.2010.00475.x

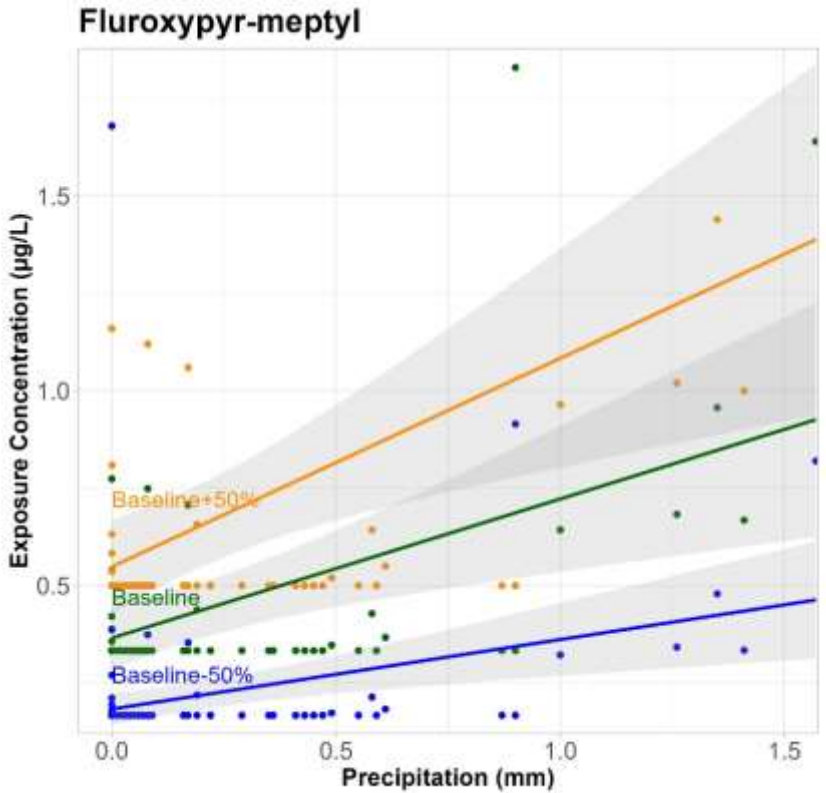
Climate Model 1
GHG emission scenario: A1B
Global climate model: HADCM3-Q0v
Regional climate model: SMHI-RCA3
Period: 2000-2100

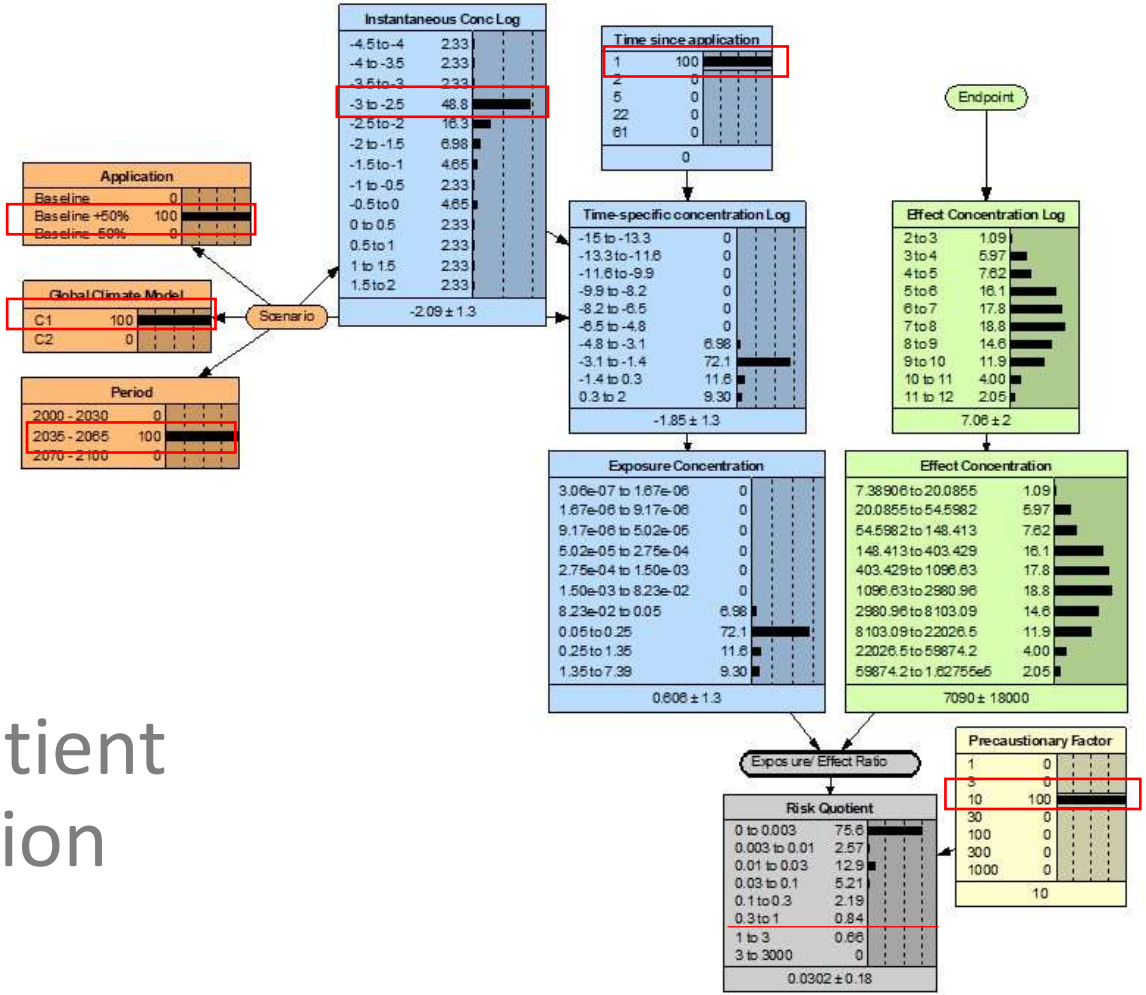
Climate Model 2
GHG emission scenario: A1B
Global climate model: ECHAM5-r3
Regional climate model: SMHI-RCA3
Period: 2000-2100

Application scenarios

Active substance	**Baseline-50%**	**Baseline**	**Baseline+50%**
	Dose active substance (kg/ha)	Dose active substance (kg/ha)	Dose active substance (kg/ha)
Clopyralid	0.025	0.05	0.075
Fluroxypyr-meptyl	0.05	0.1	0.15
MCPA	0.25	0.5	0.75
Prothioconazole	0.0875	0.175	0.2625
Trifloxystrobin	0.075	0.15	0.225

Precipitation vs predicted exposure

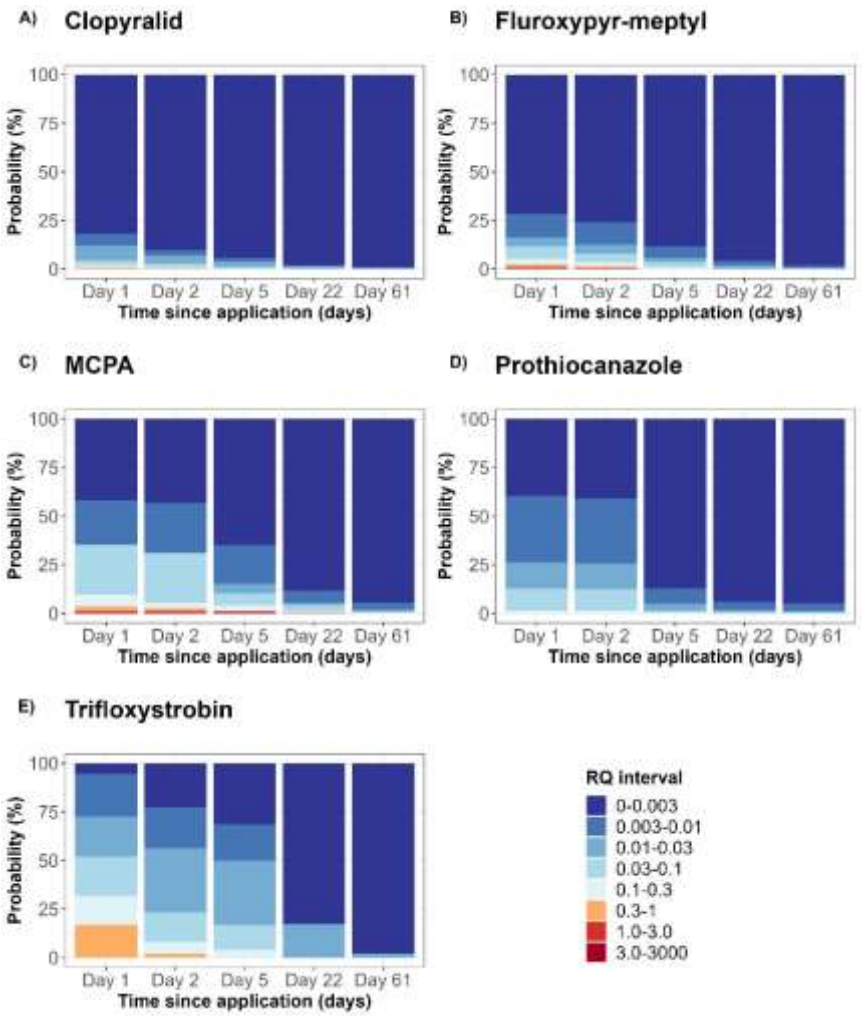




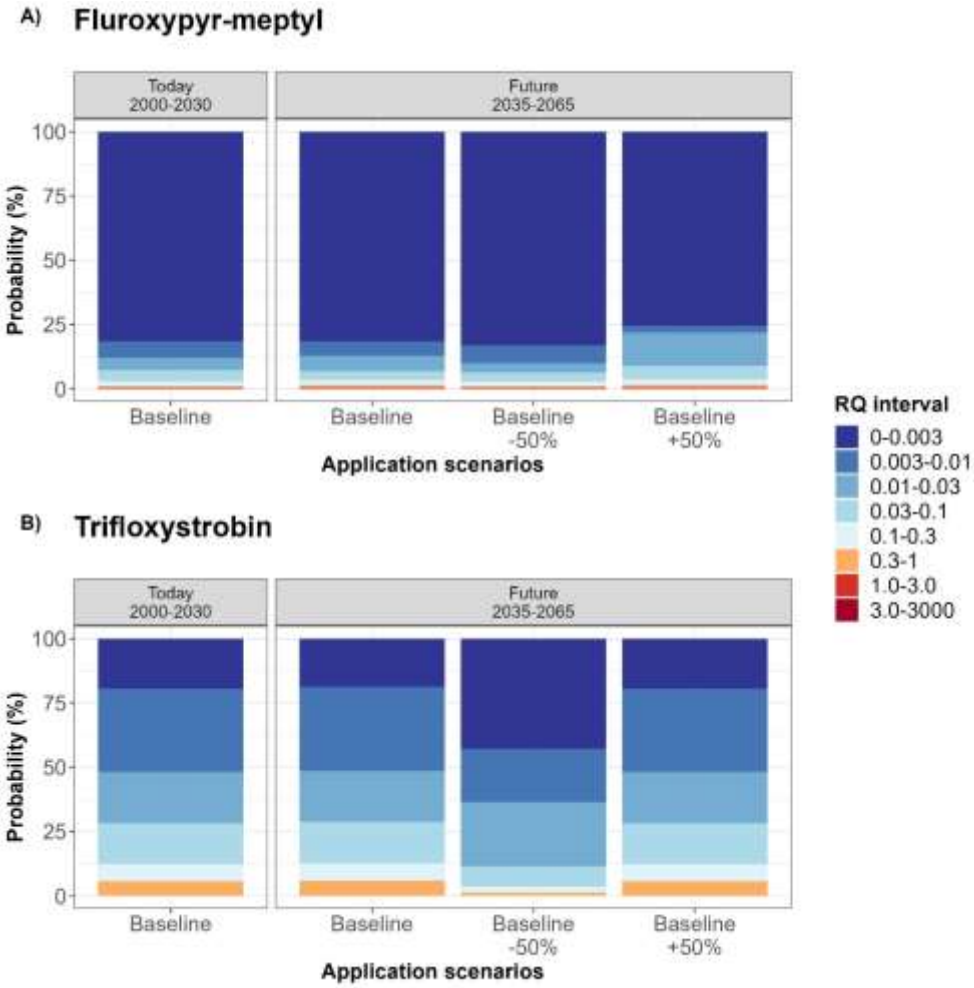
Risk Quotient Distribution

Example

Risk quotient distribution across the time since application

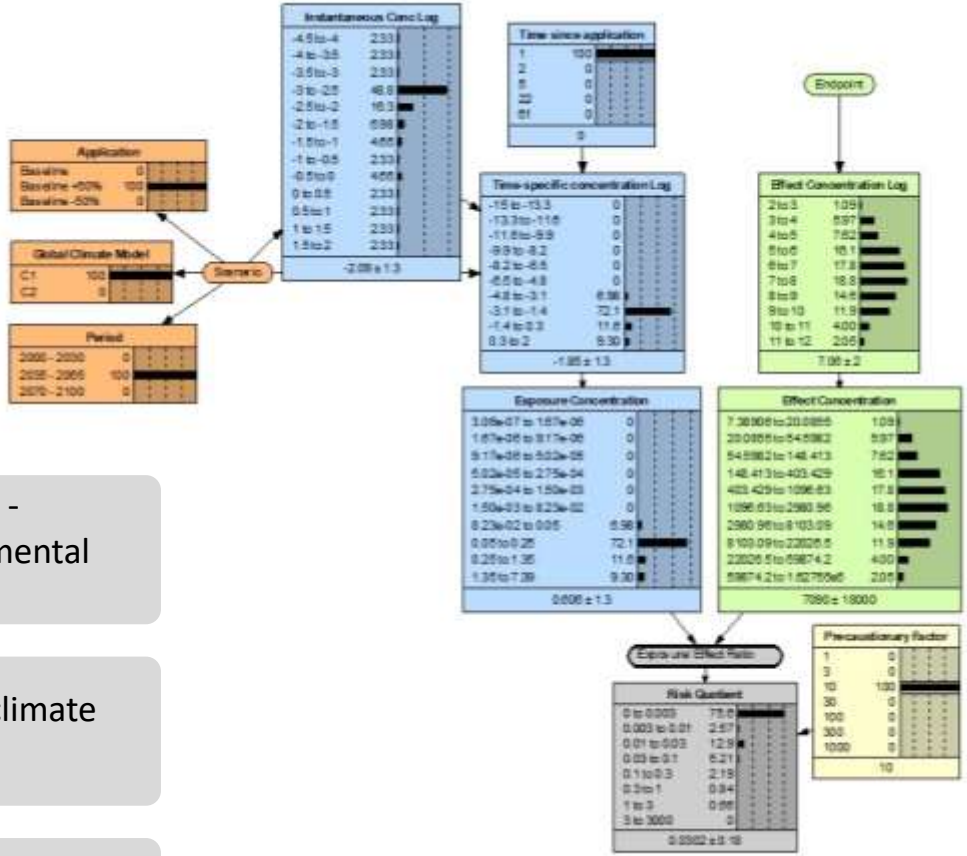


Plausible scenarios: combination of climate change and pesticide application



Summary

Mentzel et al. (2022)
doi: 10.3389/fenvs.2022.957926



We developed a probabilistic causal model - Bayesian network (BN) - to assess environmental risk of pesticides under future scenarios.

We included direct and indirect effects of climate change scenarios

We show that quantified uncertainty of all components in the BN model are propagated and incorporated in the probabilistic risk estimation

Future Outlook

- More scenarios can be developed for:
  - different crop and soil types,
  - various other pesticides,
  - Realistic pesticide emission scenarios (e.g. multiple application)
  - other climate models – preferably ensemble of climate models
- Look into climate variables e.g. temperature and precipitation vs. predicted exposure concentration
- Moving away from a risk quotient based approach

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For more information:
https://ecorisk2050.eu/

THANK YOU FOR YOUR ATTENTION!