

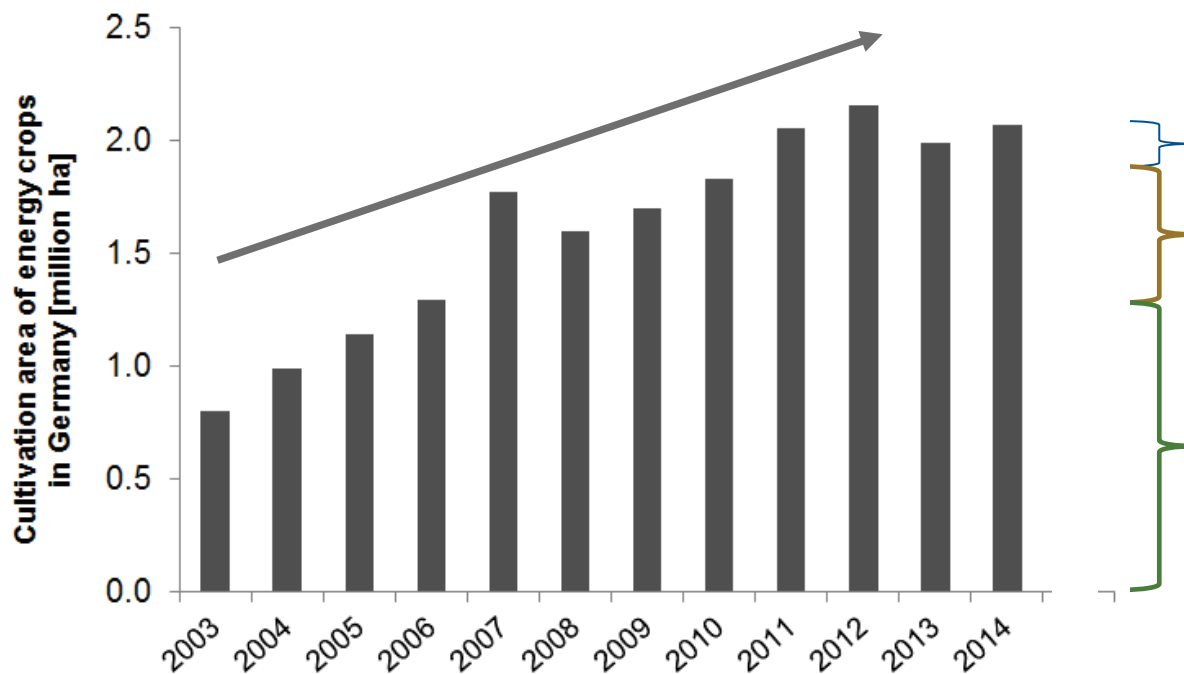


Aquatic ecosystems under increasing pressure? Energy crops and pesticide contamination of streams

Dr. Katja Bunzel
Department Bioenergy
Helmholtz Center for Environmental Research, Leipzig, Germany

European Union 2020 biofuel target

- 10% renewable energy in transport sector (mainly biofuels produced from annual agricultural crops)
⇒ ~21 million ha arable land needed
- Example: Germany



Source: based on FNR e.V. (2015)

2.1 million ha
(~18% of arable land)

Bioethanol
(80% cereals+20% sugar beet)

Biodiesel
(mainly rapeseed)

Biogas
(mainly maize)



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Pesticide use of energy crops

- Cultivation in intensive agricultural production systems
 - Pesticides



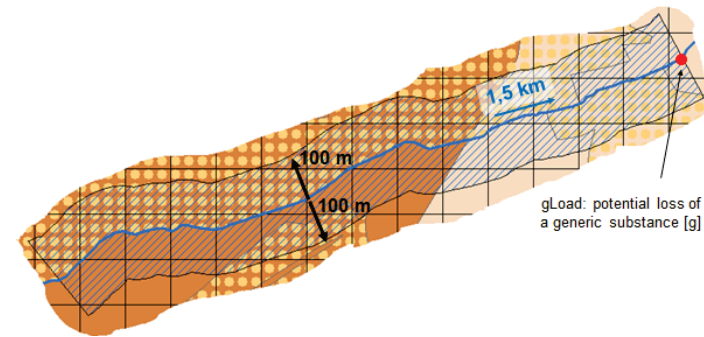
Energy crops with high or low ecological risk for stream ecosystems?

Aim:

- Comparison of pesticide exposure from six different energy crops (and related cultivation scenarios)
- Assessment of related risks for aquatic invertebrates

Material and methods

- Analysis of **pesticide exposure** for 253 sites in Central Germany with help of GIS-based Runoff Potential model (surface runoff)
 - Parameterisation with data on:
 - Land use
 - Topography
 - Soil
 - Climate
 - Pesticide use
 - Crop characteristics
- Assessment of **risk for aquatic invertebrates**: acute **toxicity** data (48h median lethal effect concentration (LC50)) of *Daphnia magna*
- Ecological Risk from potential Pesticide Runoff (**ERPR**):



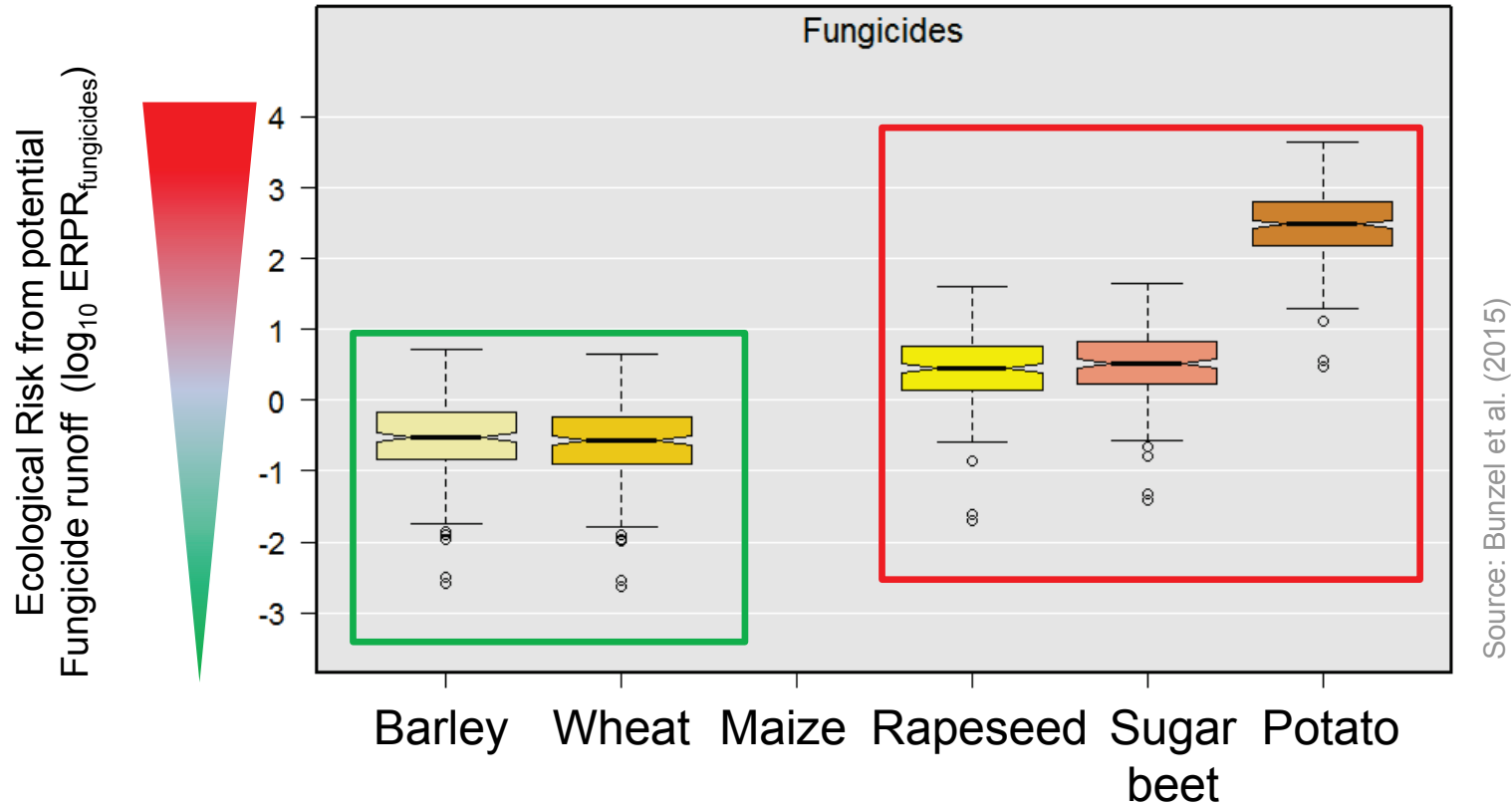
$$\frac{\text{Exposure}}{\text{Toxicity}}$$

Material and methods

- Pesticide data available for:
 - Maize
 - Potato
 - Sugar beet
 - Winter barley
 - Winter rapeseed
 - Winter wheat

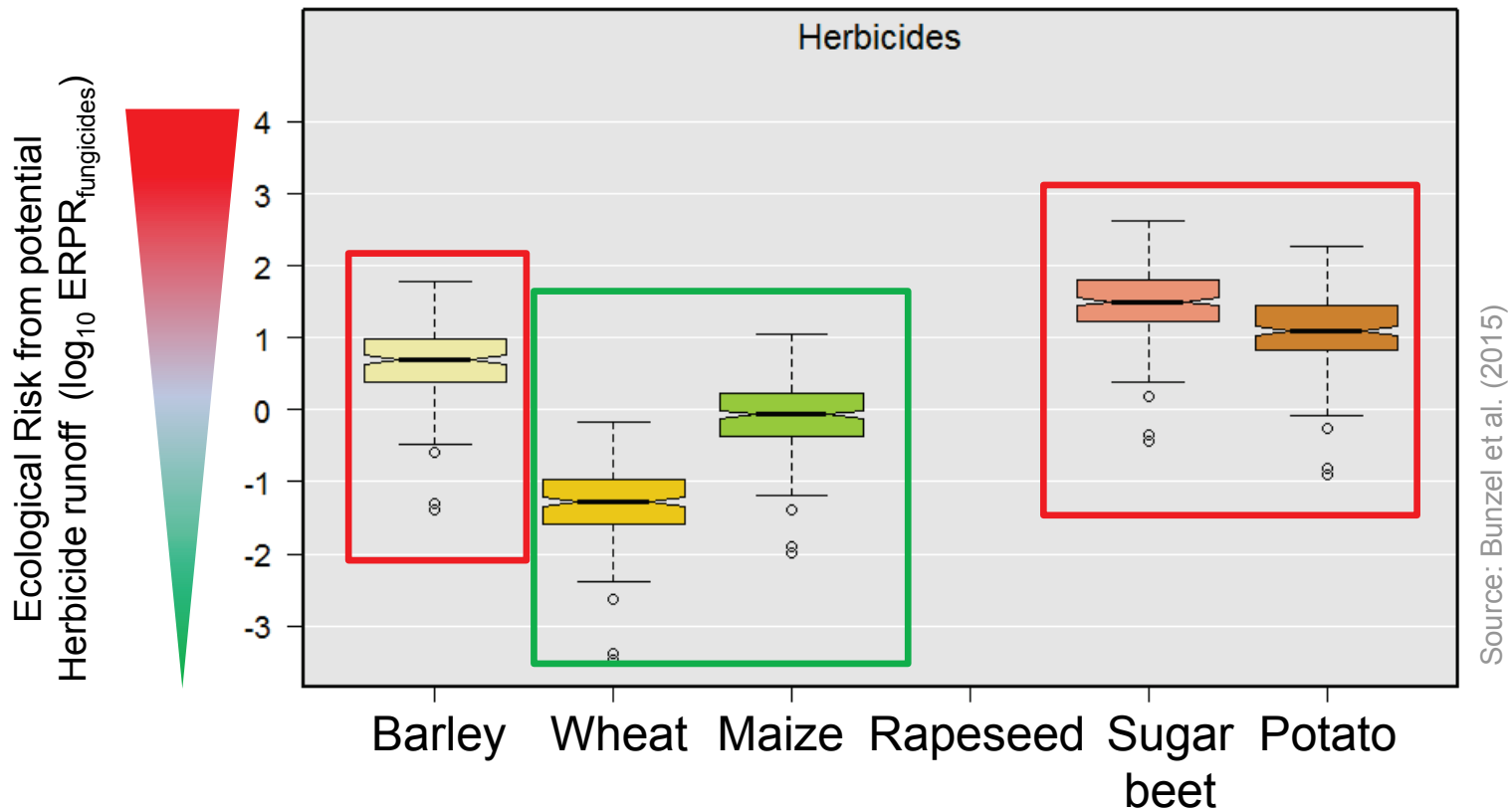
- Cultivation scenarios:
 - Reference scenarios and mixed energy scenarios
 - **Six monoculture scenarios**

Results: Spring - Fungicides



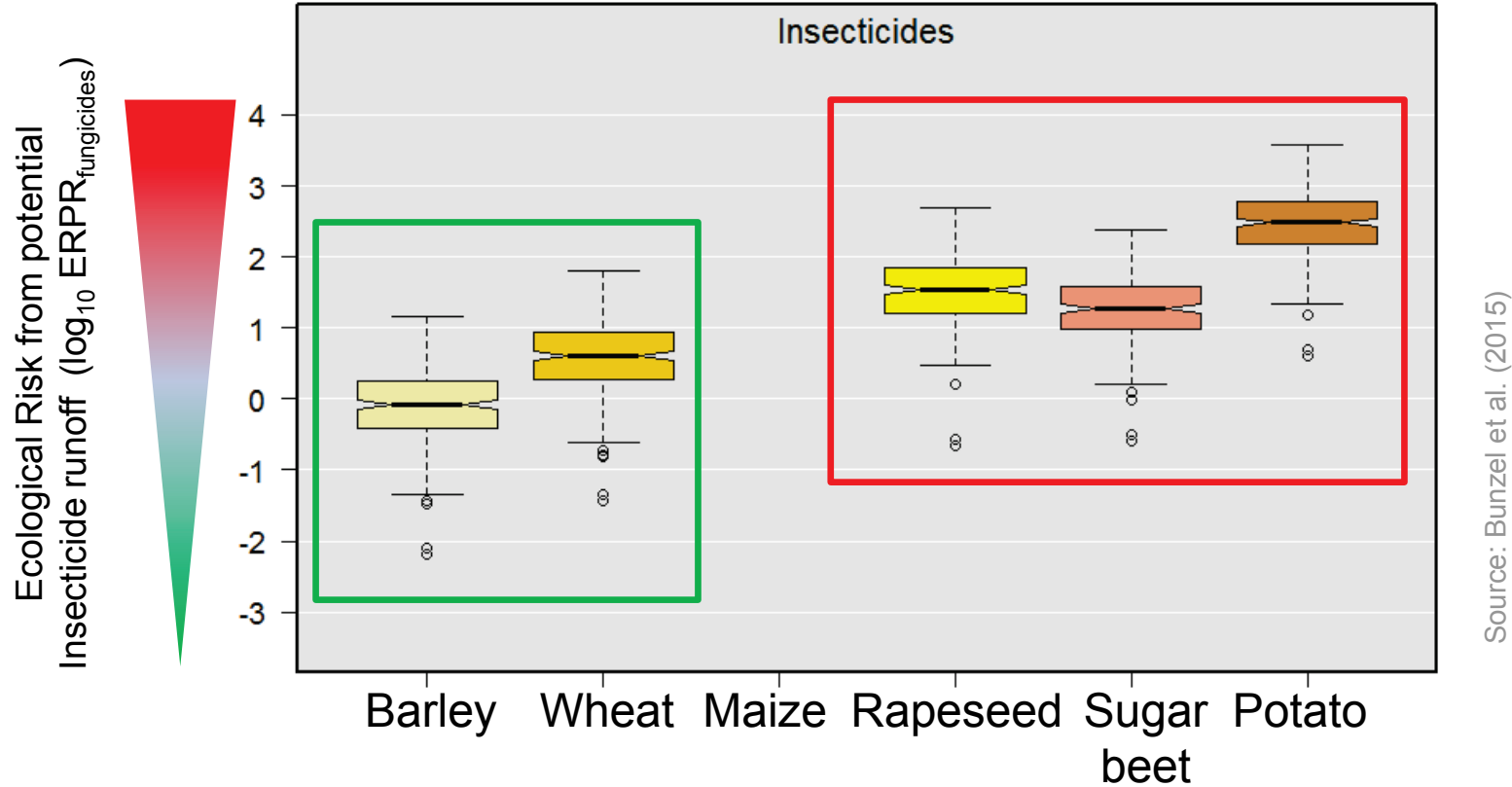
- Crops with the **highest** fungicide risk: potato, sugar beet, rapeseed
- **Lowest** risk: Wheat and barley
- No fungicide risk from maize

Results: Spring - Herbicides



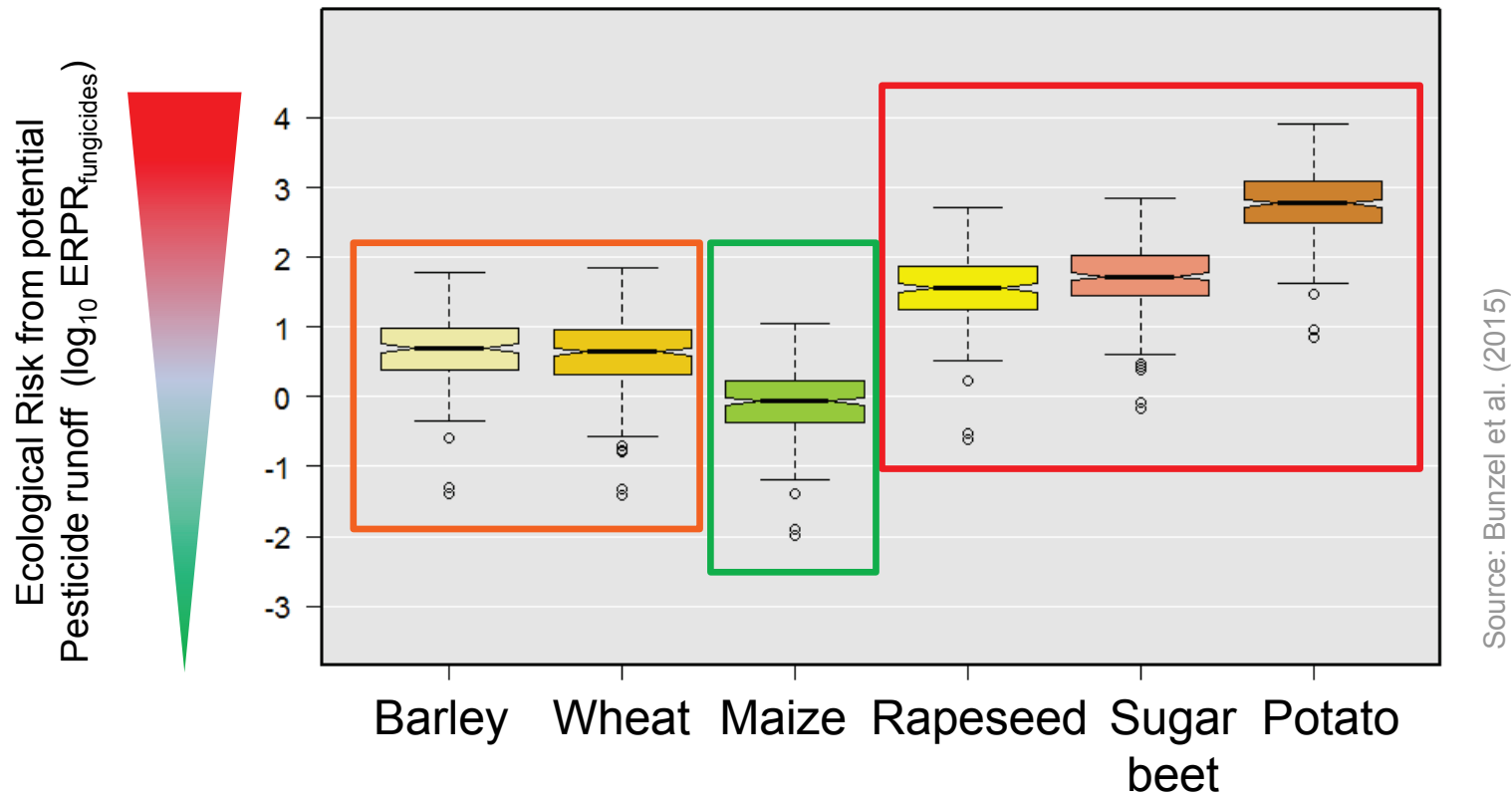
- Crops with the **highest** herbicide risk: sugar beet, potato, barley
- **Lowest** risk: Wheat and maize
- No herbicide risk from rapeseed

Results: Spring - Insecticides



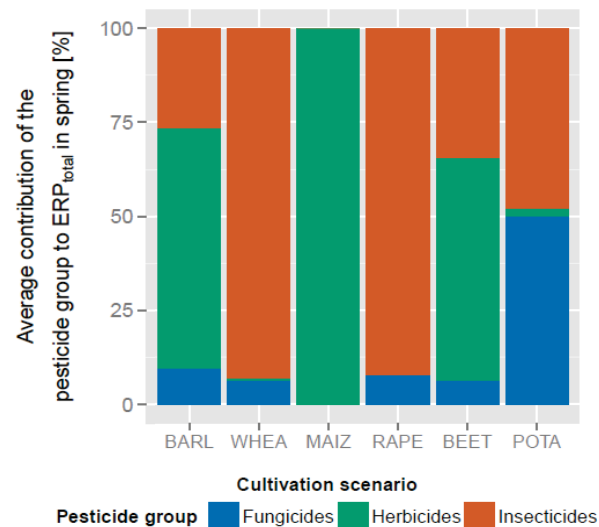
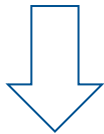
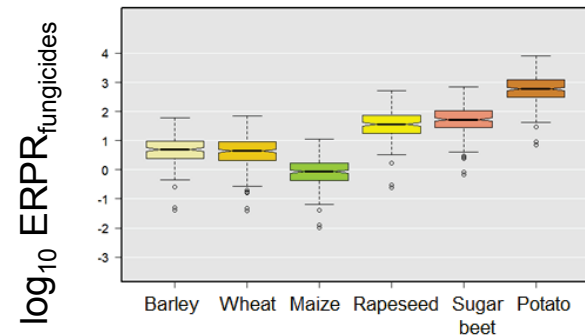
- Crops with the **highest** insecticide risk: potato, rapeseed, sugar beet
- **Lowest** risk: barley and wheat
- No insecticide risk from maize

Results: Spring - Total



- Crops with the **highest** pesticide risk: potato, sugar beet, rapeseed
- **Medium** risk: barley and wheat
- **Lowest** risk: maize

Discussion: Reasons for high risk (exemplary)



- Potato fungicides:
 - Prophylactic use to control potato late blight (6-7 applications, 7-10 days interval)
- Sugar beet herbicides:
 - Low weed competitiveness of emerged plants: 3-4 applications, ~14 days interval)
- Rapeseed insecticides:
 - Frequent occurrence of specific rapeseed pests: 1 application in autumn, 2 in spring)
 - Application of neonicotinoids (high toxicity and runoff potential)

Source: Bunzel et al. (2015)

Take-home message

- Ecological risk from pesticide runoff for aquatic invertebrates:
 - High: potato, sugar beet, and rapeseed
 - Medium: wheat and barley
 - Low: maize
- From pesticide pollution point of view: biomethane (e.g., maize) preferable to biodiesel (e.g., rapeseed)
- In general: monocultures support built-up of pathogens and pests and should be avoided ⇒ integrate energy crops in crop rotations

Thank you for your attention!

Further details:

Bunzel, K., Schäfer, R.B., Thrän, D., Kattwinkel, M. (2015): Pesticide runoff from energy crops: A threat to aquatic invertebrates? Science of the Total Environment 537:187-196. doi: 10.1016/j.scitotenv.2015.08.011



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