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Shaping climate change adaptation in agriculture towards regional conditions – an interdisciplinary approach

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IGLU Ingenieurgemeinschaft für Landwirtschaft und Umwelt www.iglu-goettingen.de

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ptble Projektträger Bundesanstalt für Landwirtschaft und Ernährung

aufgrund eines Beschlusses des Deutschen Bundestages

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Overview

1. Interdisciplinary analysis of climate change in agriculture
2. Methods
3. First preliminary results
4. Outlook

1. Interdisciplinary Analysis of climate change on agriculture and adaptation of arable systems

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Phenomena observed

- general warming / partly dry springs and summers
- relocation of precipitation (summer ↓, winter ↑)
- extreme weather events (e.g. dry periods, heat waves, storms)
- increase of CO_2-concentration

Bilder: pixabay.com; JKI/Schlage/Schober

Agriculture is especially hit

- yield fluctuations
- increased pest pressure (parasites, fungal pests e.g. cereal rust)
- additional labour need (e.g. irrigation)
- …

As reaction on changing conditions, adaptations of arable systems are required.

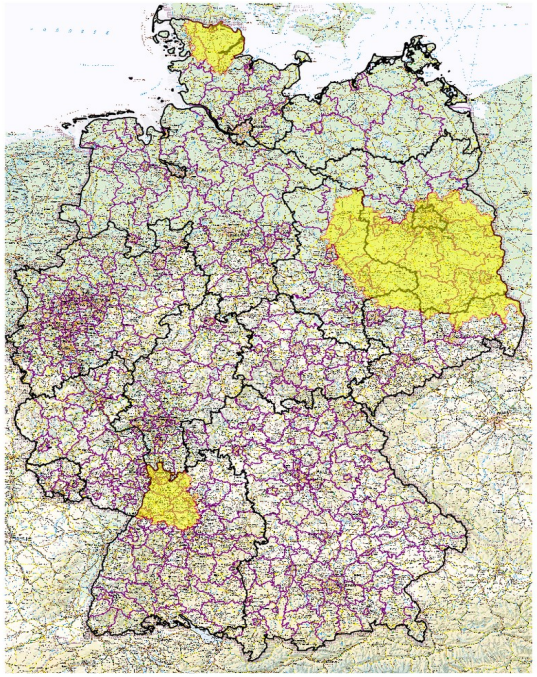
Project Aims

Improvement of **regional & practical** cropping strategies for the adoption to climate change and for reduction of GHG emissions, by:

- **Analyses und assessment on landscape level**
- **close collaboration with local actors from the agricultural sector (co-design)**

Adaptation strategies consider

- interactions between crop shares, crop protection, productivity, profitability and GHG emissions
- trade-offs and synergies towards other sustainability goals (e.g. climate, environment, water, and soil conservation)



OptAKlim model regions North, Eeast and Southwest

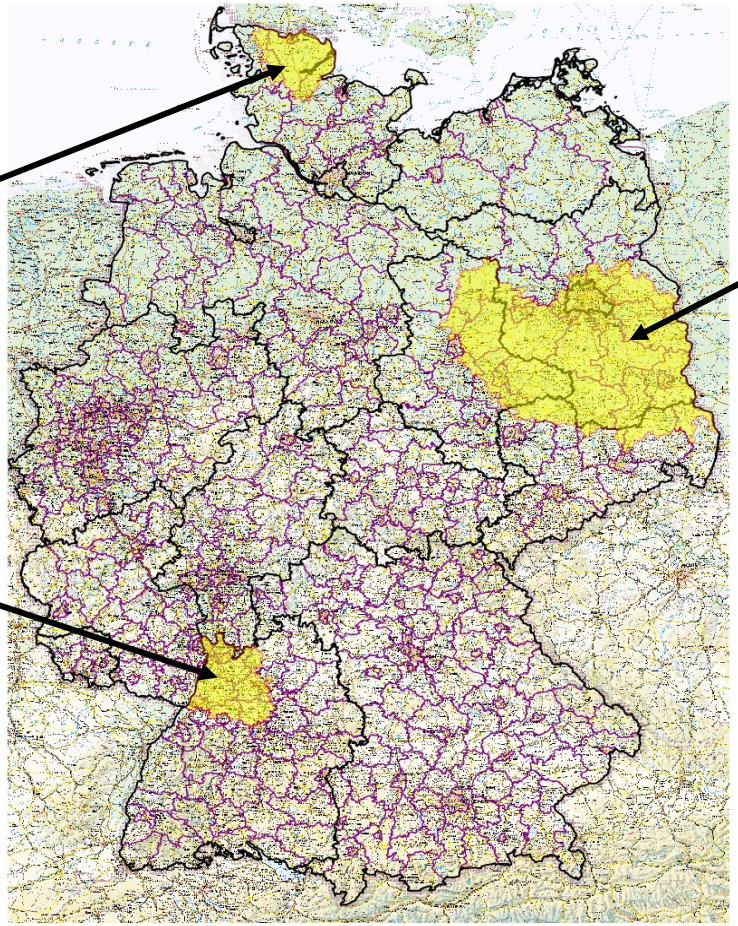
2. Methods

Modell Regions

We consider three model regions (agri-environmental zones)

North:
Schleswig-Holstein, Rendsburg/Flensburg

South-West:
Baden-Württemberg, Karlsruhe/Heilbronn



East:
Brandenburg, Teltow-Fläming und Potsdam-Mittelmark

Working Steps

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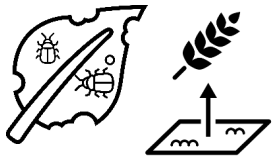
Which effects of climate change are observed already in the region?

How will **climate change** in **the next decades**?

Which **adaptation strategies** exist already? How do they work?

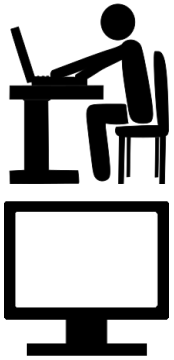


Investigation of **climate change scenarios** on:

incidence of pests, crop protection strategies, yield and crop choice

Identification of **regional problem issues** and determination of regional **climate adaptation strategies**

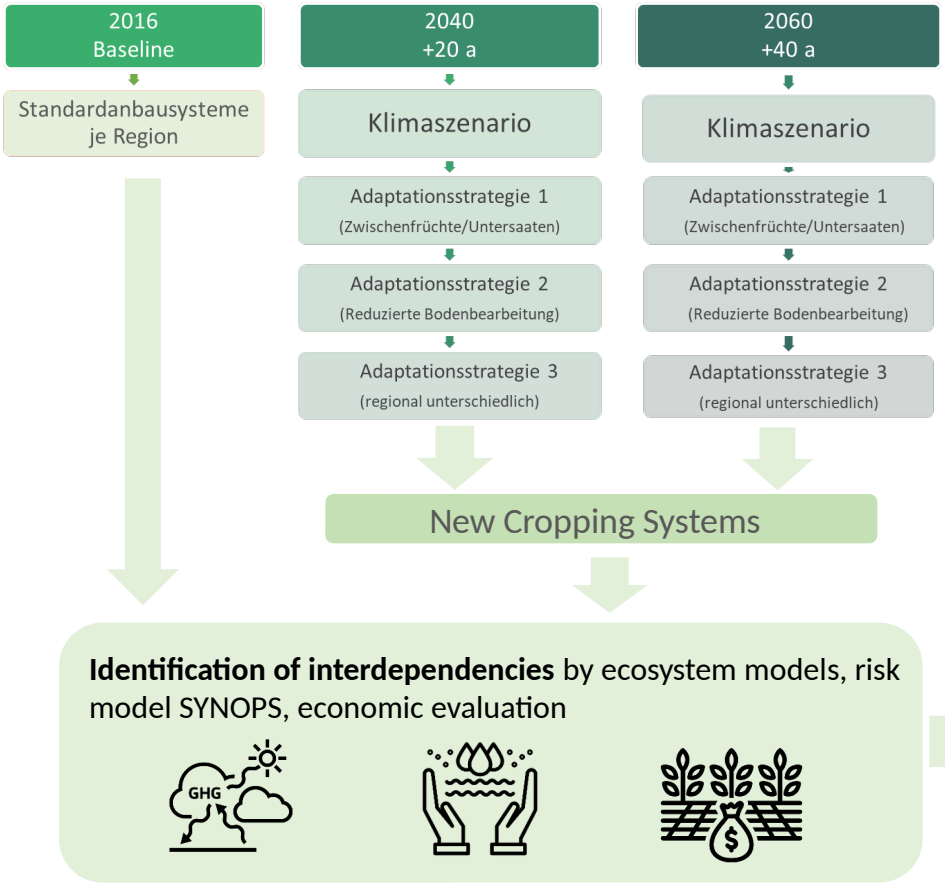
Results of farmers vote on adaptation strategies:
1. reduced tillage
2. intercropping/undersown crops
3. East: improvement of water efficiency
3. North: improvement soil biological activity
3. Southwest: diversification



Interdisciplinary analysis of existing practices and adaptation strategies

Set up of a **web tools** (Synops-Web+) for counselling of farmers

Scenarios



- **Optimization of cropping strategies and derivation of regional recommendations**

→ Multi goal optimization

- Provision of the results in an **OptAKlim web portal**
- Provision of **extension tool Synops-Web+**

for a site specific estimation of environmental risks by crop protection applications

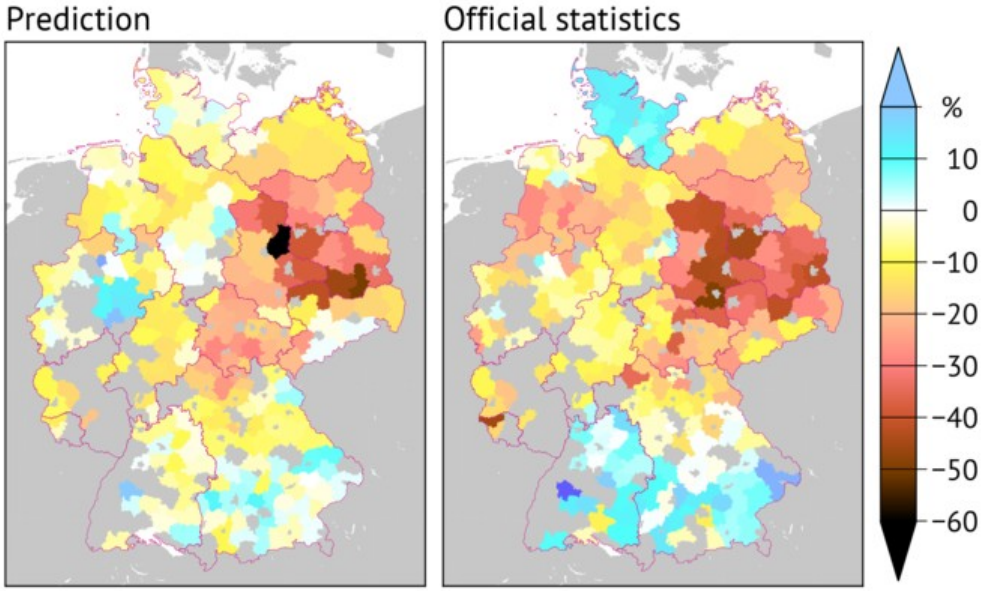
+ economic evaluation of cropping strategies

+ evaluation of GHG emissions

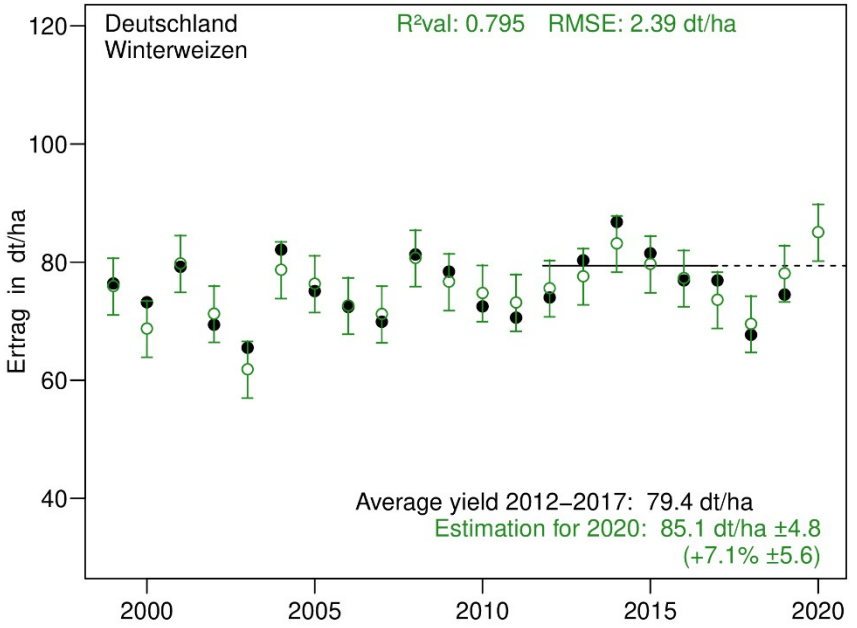
Yield Estimation

Modelling of annual district yields with a multiple linear regression model in dependence of weather data. Use of weather data from DWD and official yield statistics.

Example of the projection of silage maize yields for 2019 (left) in comparison to actual yields (right). Visualization of relative differences to the averages 2012–2017.



Comparison of national yield averages for winter wheat between model results and observations.



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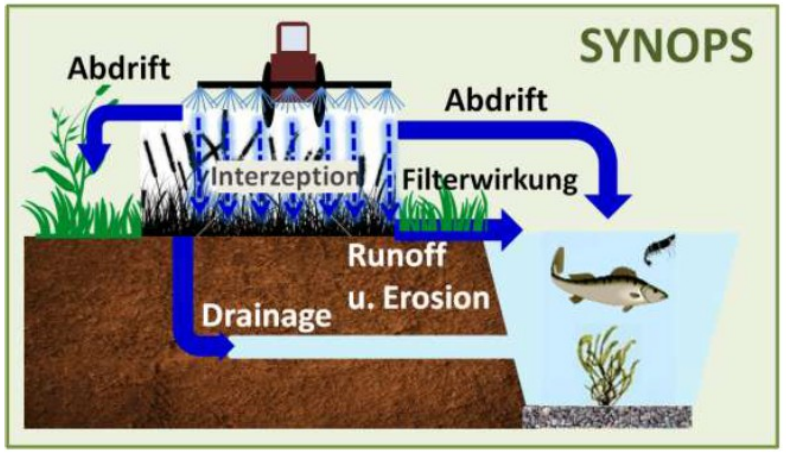
Interdisciplinary Evaluation

- Economic Aspects: Data base related calculation of gross and net margins (ADEBAR$^{(BE)}$)
- Shift in land use: Modelling with MODAM (Linear Programming with constraints)
- Cumulated energy consumption and GHG emissions: Modelling with MiLA (Model for integrated Life Cycle Assessment in Agriculture)
- Environmental risks of pesticide applications: Modelling with Synops-WEB

Estimation of Environmental Risks of Crop Protection application with SYNOPS-WEB

SYNOPS-WEB contains risk indices for surface water, soil and side vegetation, which are selected, applied and visualized.

- consideration of specific shape and location of fields
- consideration of weather and location of water bodies
- consideration of crop type and specific crop protection measures
- available as online tool



Quelle: JKI

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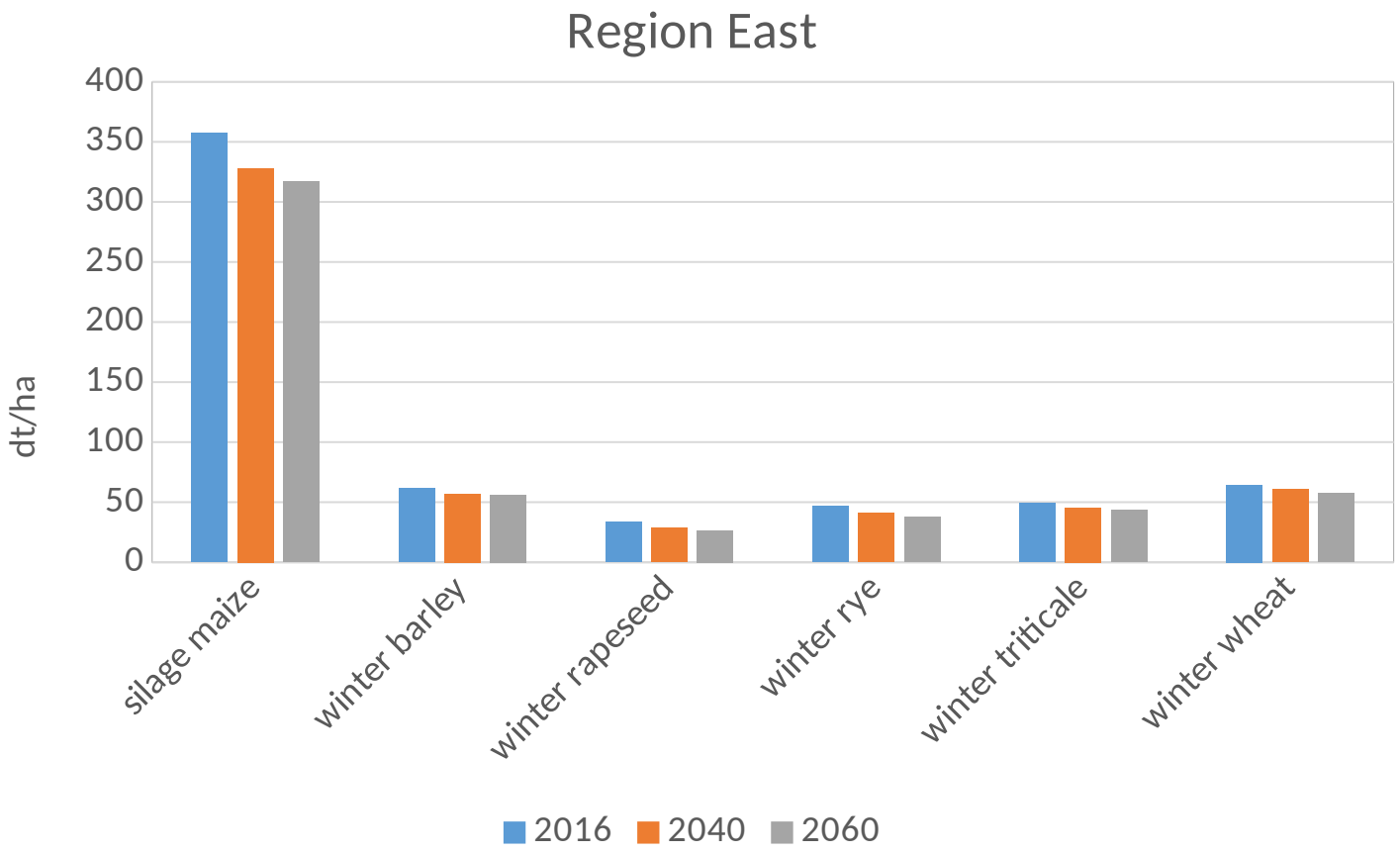
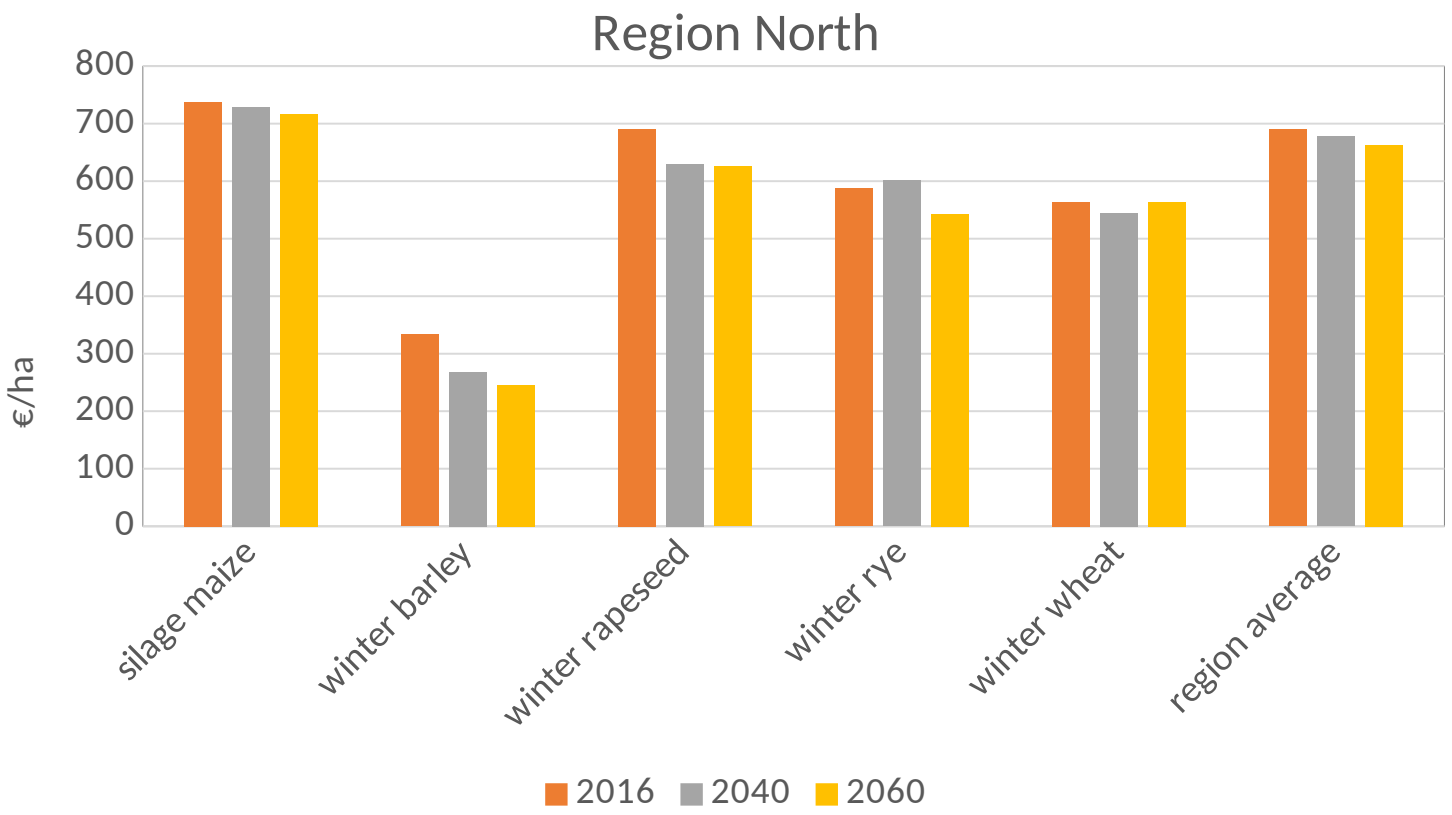
3. First Preliminary Results

Yield Changes on a Regional Scale



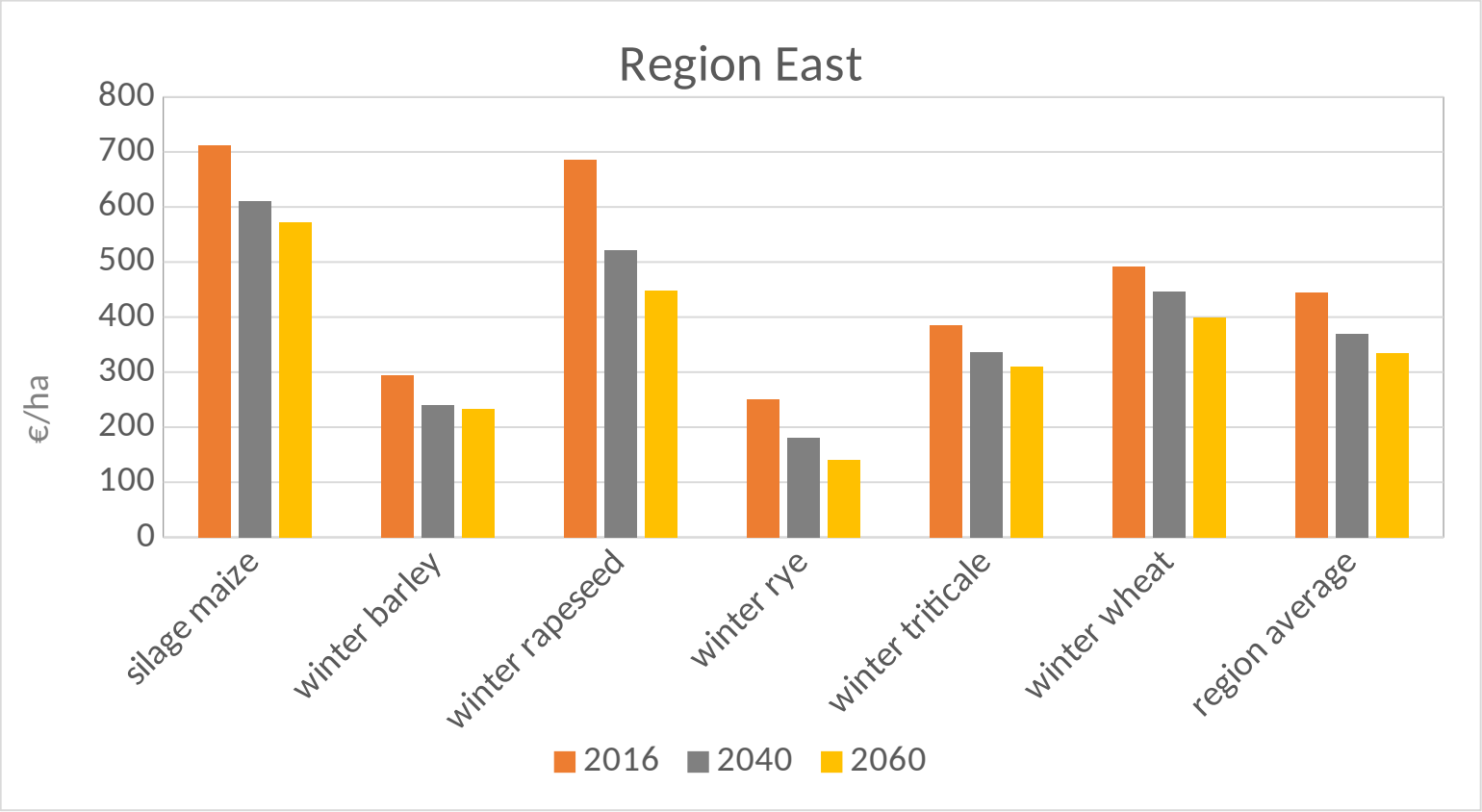
Yields tend to decline, with some exceptions (wheat in region North, silage maize in region Southwest, 2060)

Change in Gross Margins by Climate Change (1)



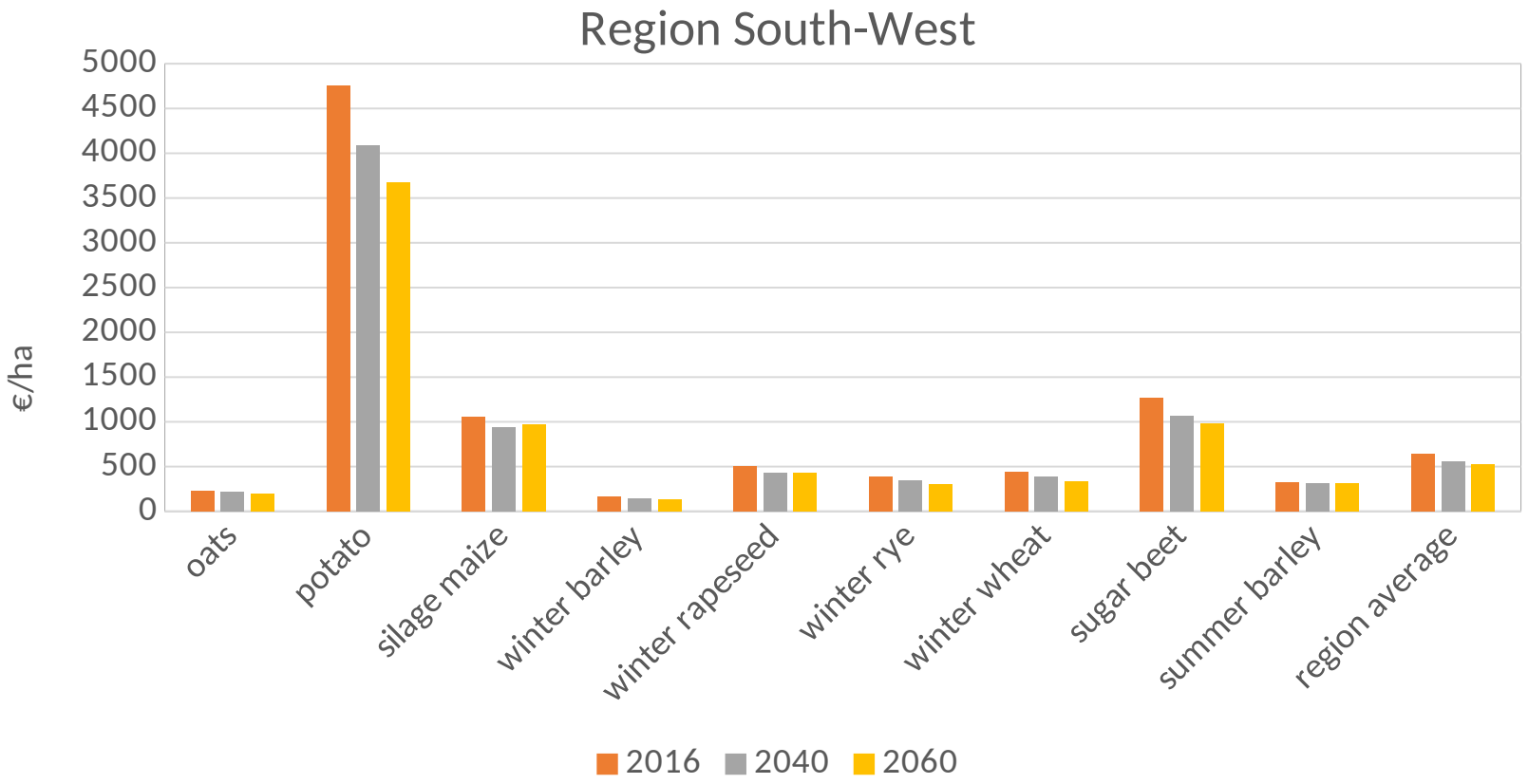
 decreasing tendency of gross margins in line with yields. Different crops are affected to different extents.

Change in Gross Margins by Climate Change (2)



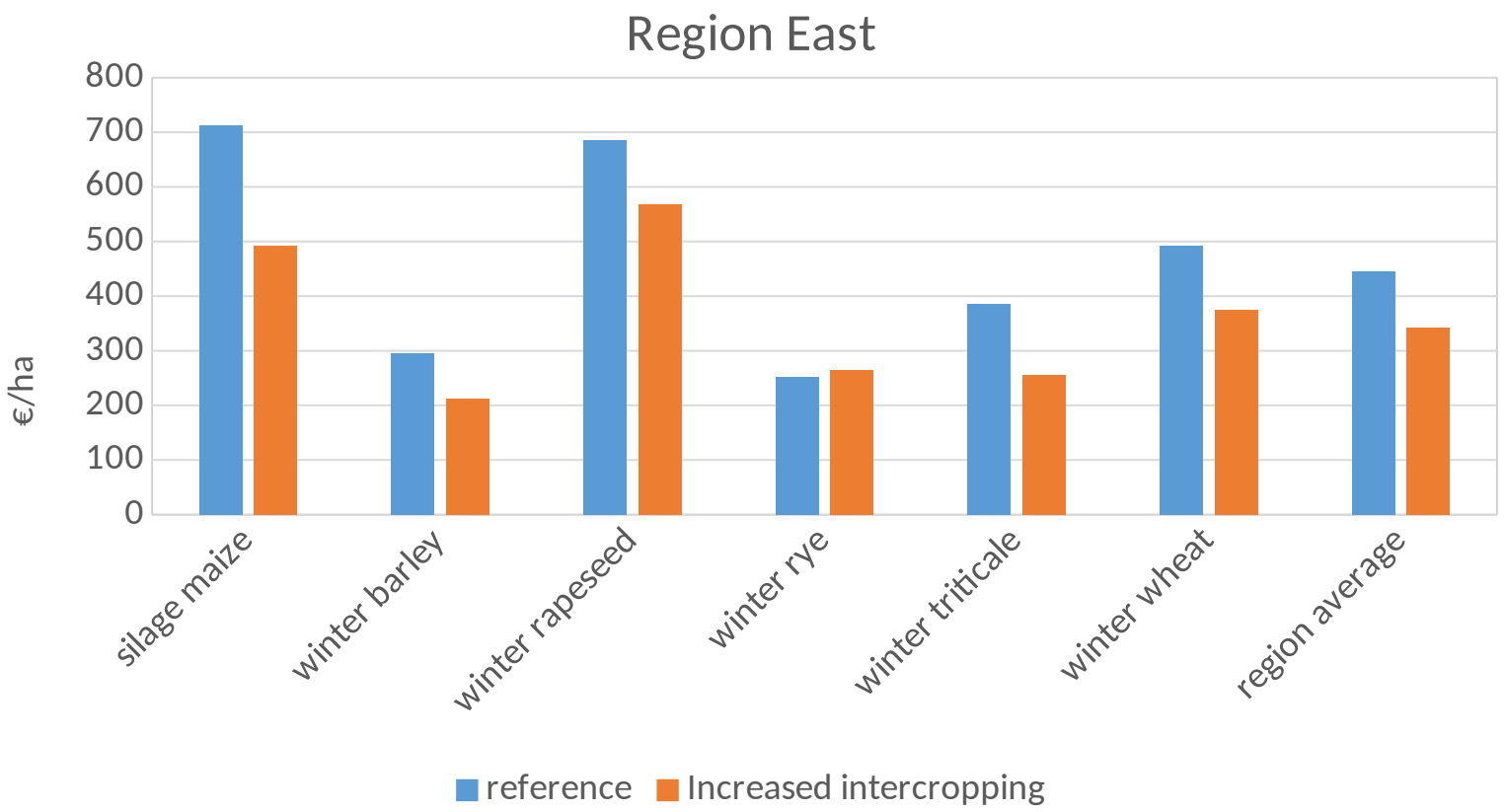
Region East is much harder hit by climate change effects!

Change in Gross Margins by Climate Change (3)



In South-West, especially highly profitable potatoes are hit, however, they remain highly lucrative.

Comparison of current system with increased intercropping



Obviously, costs of intercropping reduce profitability. Whether this can be offset by additional environmental services is subject to further studies.

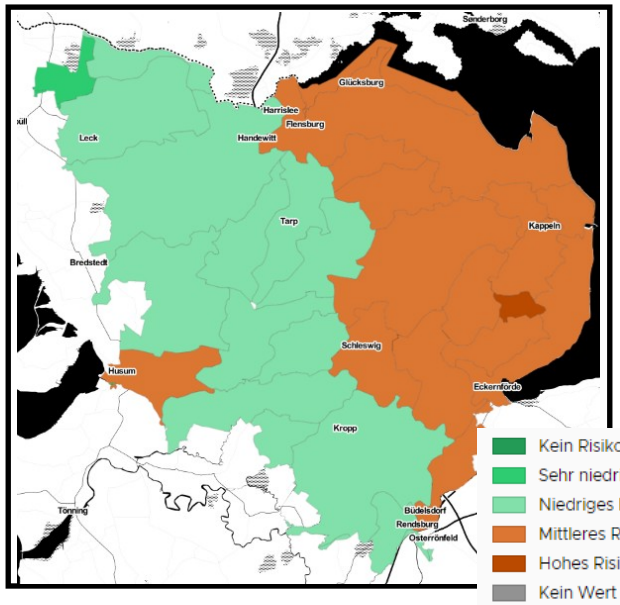
Aquatic Risks by Crop Protection Applications (Reference scenario only)

Reference scenario: average of 9 years

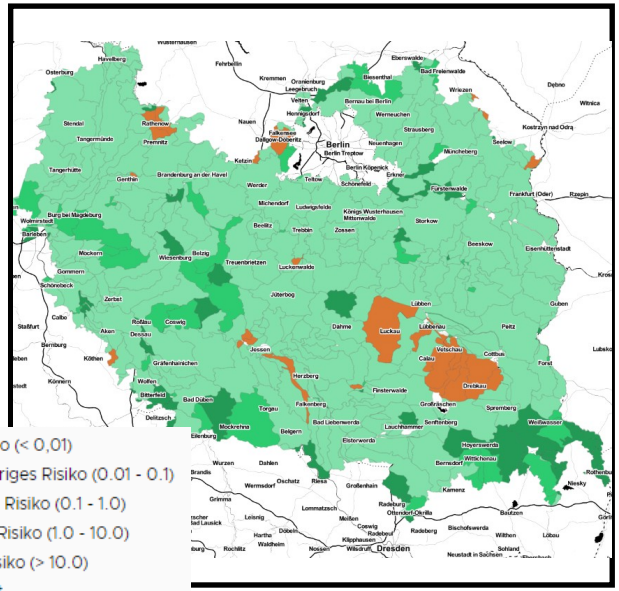
Acute aquatic risk

- Crop share according to observed statistics per municipality
- weather data: DWD grid-based 2010 -2018
- Crop protection: generic application schemes (3 intensities per crops and year)
- 90. percentile per catchment
- Flexible analyse in OptAKlim MAP-Viewer possible: https://sf.julius-kuehn.de/mapviewer-staging/optaklim/optaRiskanalysis

North 2018

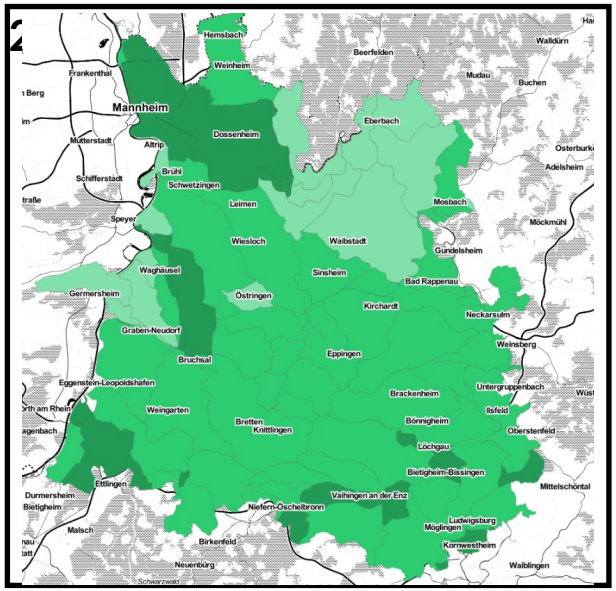


East 2018



Kein Risiko (< 0,01)
Sehr niedriges Risiko (0.01 - 0.1)
Niedriges Risiko (0.1 - 1.0)
Mittleres Risiko (1.0 - 10.0)
Hohes Risiko (> 10.0)
Kein Wert

South-West



Aquatic Risk by Crop Protection Applications

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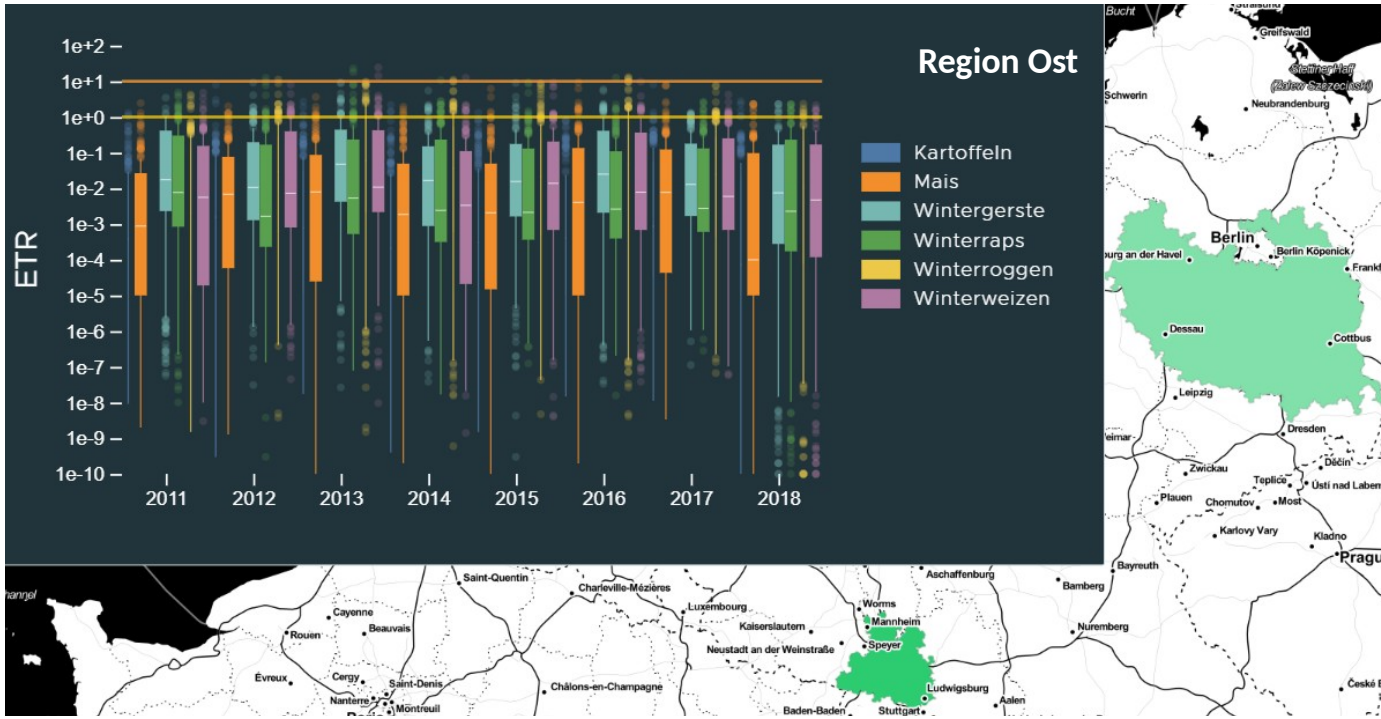
Reference scenario: average of 9 years
Acute aquatic risk

Detailed analyses can be carried out with OptAKlim MAP-Viewer
https://sf.julius-kuehn.de/mapviewer-staging/optaklim/optaRiskanalysis

- per region and crop
- different risk indicators:
  - aquatic organisms
  - soil organisms
  - non target arthropods
- different spatial aggregation methods
  - 90./80. Percentile
  - area share of ETR > 1
  - area share of ETR > 10



4. Outlook

- Completion of missing scenarios
- Completion of interdisciplinary evaluation
- Identification of trade-offs and synergies between various economic and ecological indicators of arable strategies
- Contribution to GHG reduction through optimization of cropping strategies, regionally adapted
- Online tool SYNOPS-WEB+ will be available to the public also outside the model regions

Thank you for your attention!

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