



Integrated Assessment of Climate Change Impacts on Farms and Ecosystems in a Grassland Dominated Austrian Landscape

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History of orchard meadows

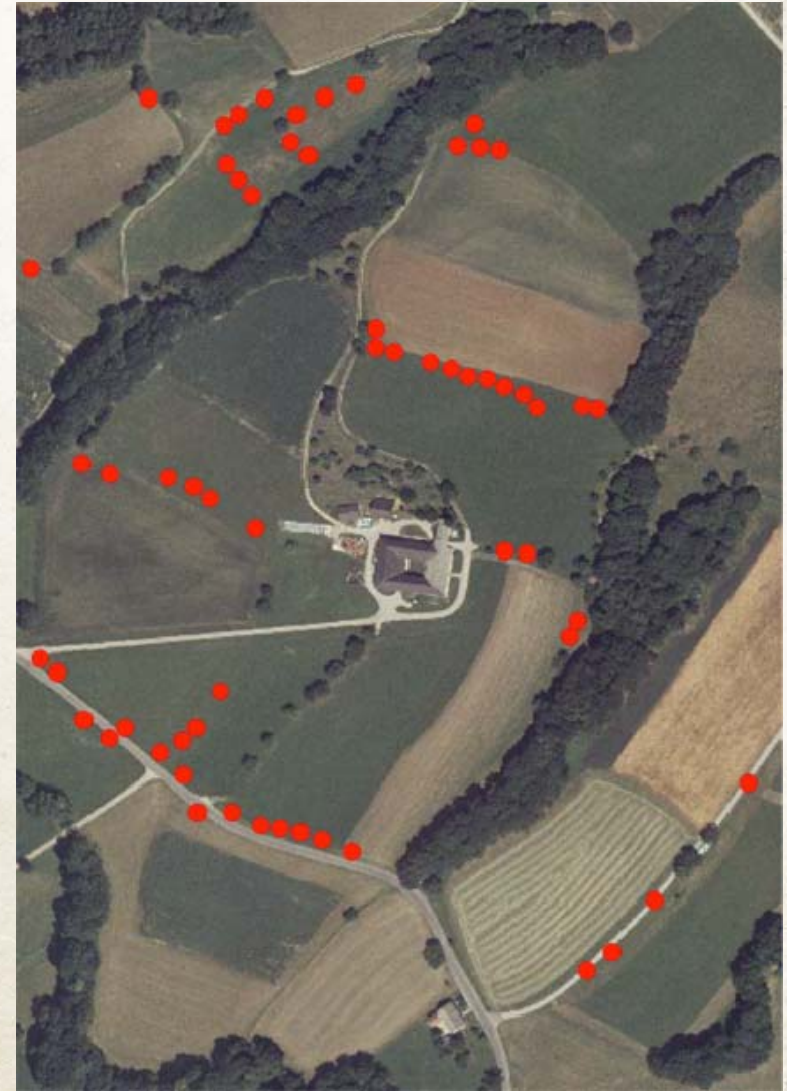
(Streuobstwiesen)

Up to the 1950ies

Wide spread of orchard meadows around farms, on grassland and along field borders

Since then...

Permanent decrease of fruit trees and orchard meadows

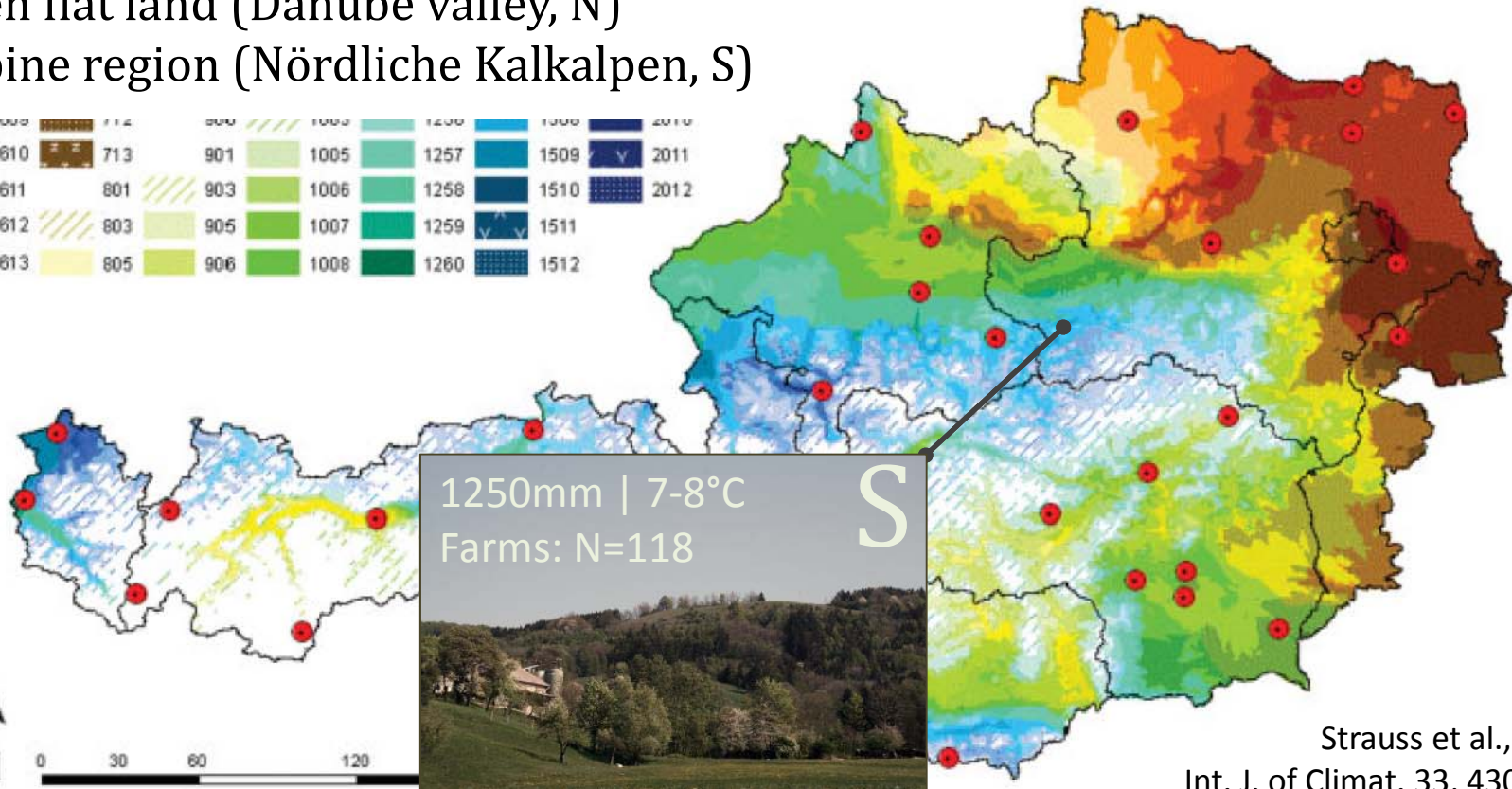


Case study landscape

Clusters 703 806 907 1009 1261 2000

Mostviertel

geological transition zone
between flat land (Danube valley, N)
and alpine region (Nördliche Kalkalpen, S)



Strauss et al., 2013.
Int. J. of Climat. 33, 430–443.

Methods and Data

Input

natural & socio-economic data

input and output prices
CAP
production functions
farm labor supply
livestock – herd sizes
observed land use
spatially explicit field data
landscape elements
climate scenarios
topography
soil characteristics

Models

CropRota¹



EPIC²

CALDIS VÂTIS⁴



FAMOS[space]³

Output

socio-economic & RD indicators

farm gross margin
public budget spending
farm labor demand
landscape diversity & appearance

agri-environmental indicators

agric. & forestry land use change
biodiversity
SOC
soil sediment loss
N & P nutrient balances
GHG emissions

food production indicators

crop & livestock production

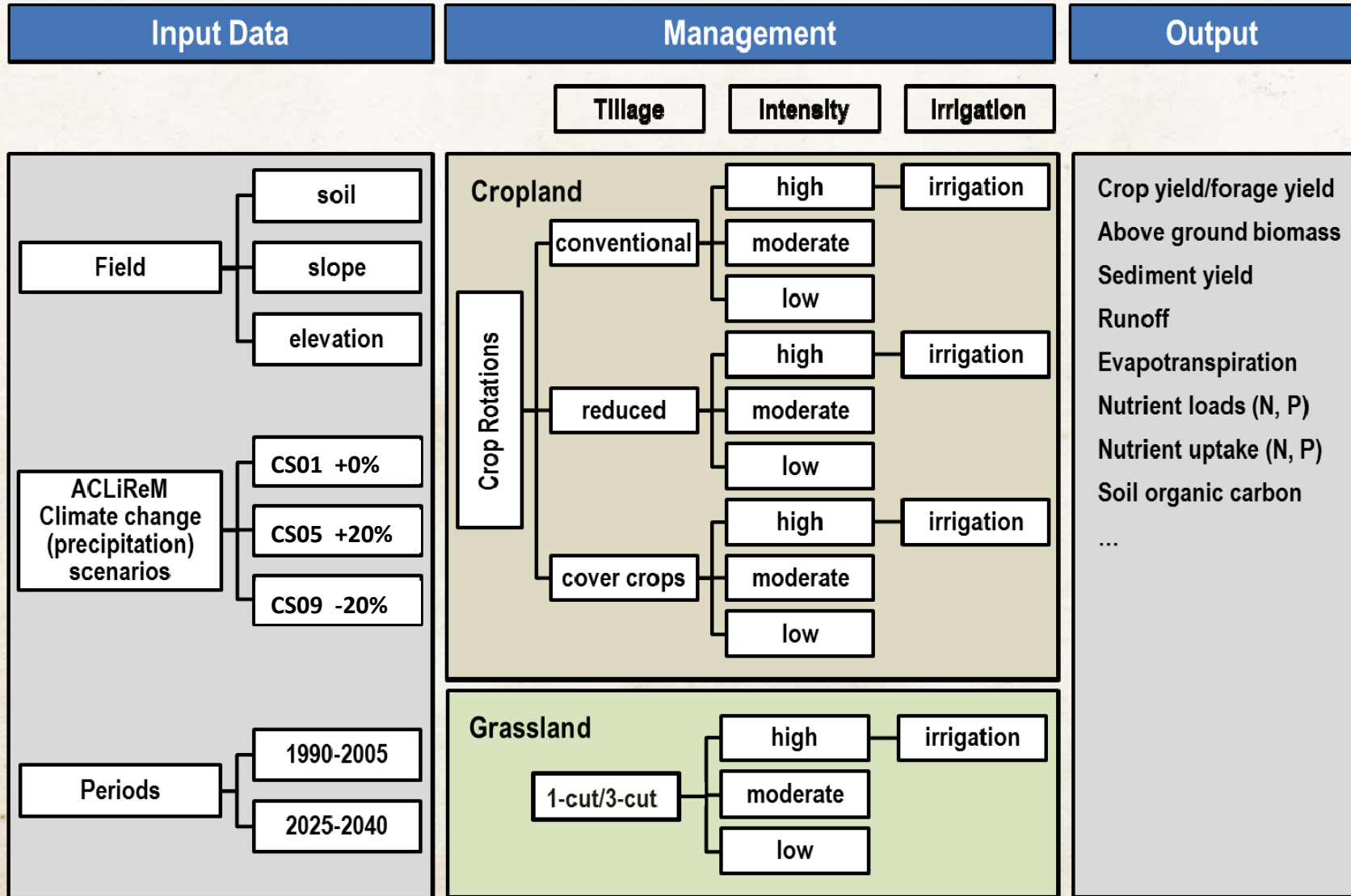
¹Schönhart et al. (2011). Eur J Agron 34, 263-277.

²e.g. Izaurralde et al. (2006). Ecol Modell 192, 362-384.

³Schönhart et al. (2011). J Environ Plann Manage 54, 115-143.

⁴Georg Kindermann, BFW (see Kirchner et al., (2015). Ecol Econ 109, 161-174).

EPIC – model run settings



Output

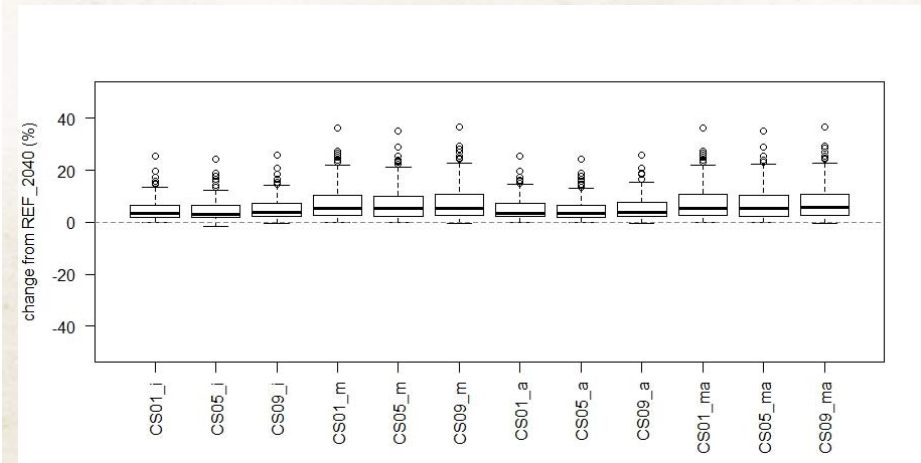
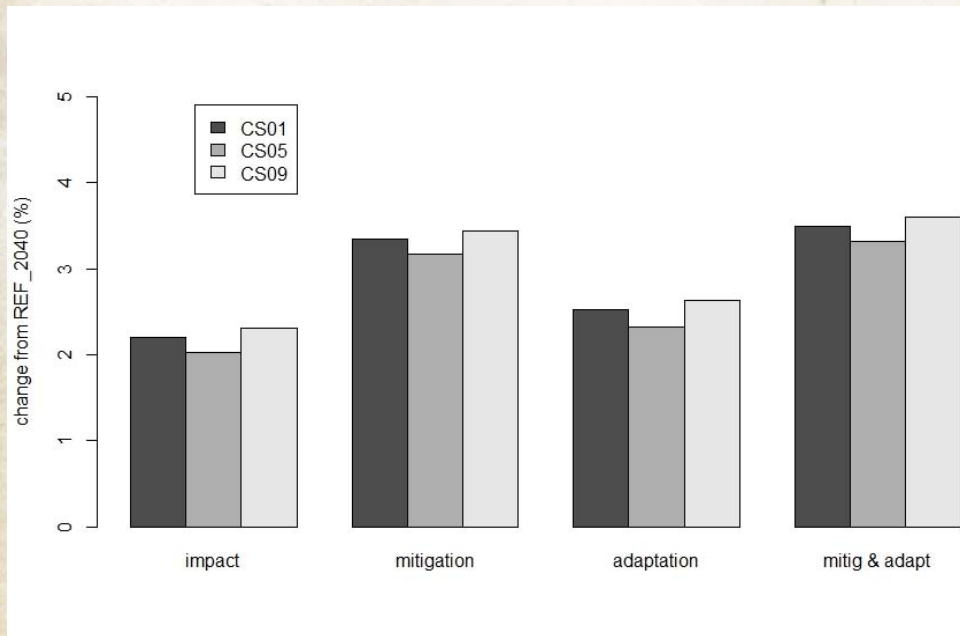
- Crop yield/forage yield
- Above ground biomass
- Sediment yield
- Runoff
- Evapotranspiration
- Nutrient loads (N, P)
- Nutrient uptake (N, P)
- Soil organic carbon
- ...

Impact, mitigation & adaptation scenarios

Name	CC*	AEP*	CAP reform	Mitigation policies	Adaptation policies														
REF_2040	No	No	no dairy quota; no livestock premiums; regional farm payment; greening; LFA payments from 2008	<table border="1"> <thead> <tr> <th rowspan="2">Climate Change [CC] Scenario Name</th> <th colspan="2">Climate change in 2040</th> </tr> <tr> <th>Δ temperature (°C)</th> <th>Δ precipitation (%)</th> </tr> </thead> <tbody> <tr> <td>CS01</td> <td>+ 1.5</td> <td>0%</td> </tr> <tr> <td>CS05</td> <td>+ 1.5</td> <td>+20%</td> </tr> <tr> <td>CS09</td> <td>+ 1.5</td> <td>-20%</td> </tr> </tbody> </table>	Climate Change [CC] Scenario Name	Climate change in 2040		Δ temperature (°C)	Δ precipitation (%)	CS01	+ 1.5	0%	CS05	+ 1.5	+20%	CS09	+ 1.5	-20%	
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CS05	+ 1.5	+20%																	
CS09	+ 1.5	-20%																	
CS[CC]_i	Yes	No	like REF_2040																
CS[CC]_m	Yes	No	like REF_2040	energy crops on set aside; subsidies for: landsc. elements, SRF, afforestation, cover crops, min. tillage and extensive land use															
CS[CC]_a	Yes	No	like REF_2040		no greening, subsidies for maintenance of steep slope grass land and irrigation														
CS[CC]_ma	Yes	No	like REF_2040	like CS[CC]_m	like CS[CC]_a														

* CC...climate change, AEP...agri-environmental program

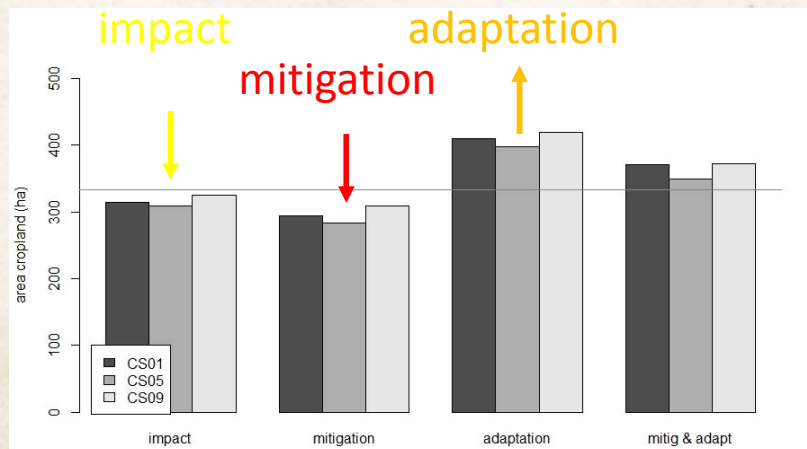
Prelim. Results – changes in farm gross margins from climate change and policies



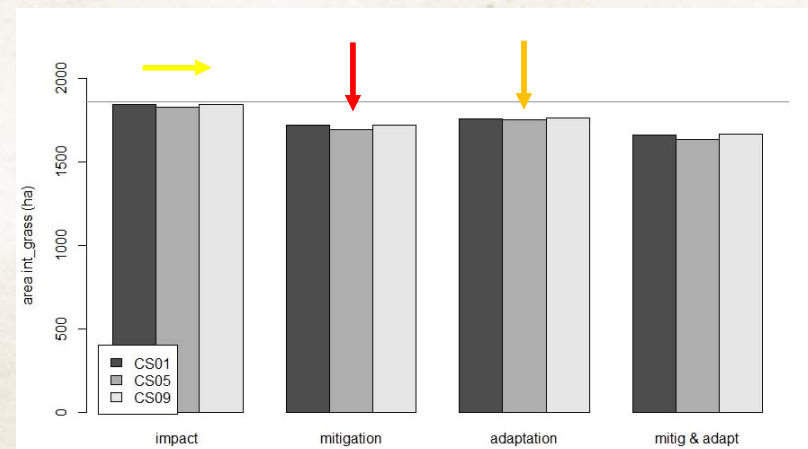
Gross margin: + product sales (plant, livestock) + subsidies + annuities for long-term investment
- variable costs (machinery, inputs and services, off-farm labor)

Prelim. Results – land use impacts (ha) from climate change and policies

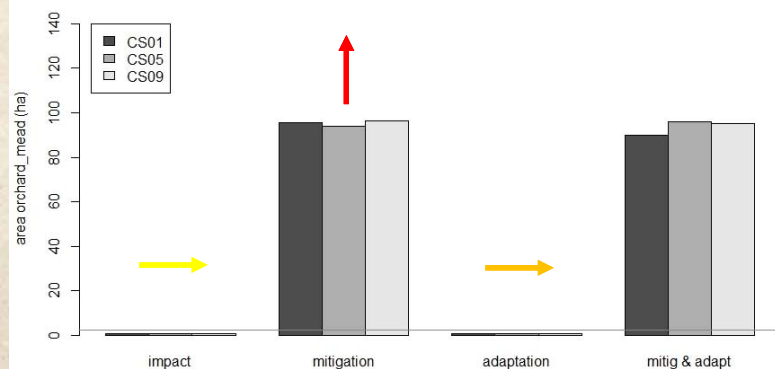
Cropland



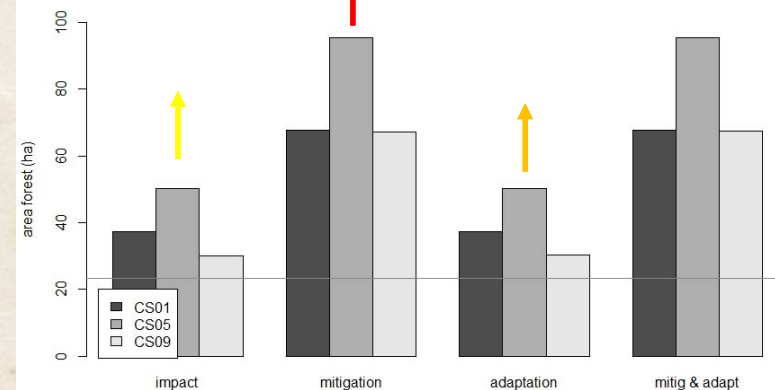
Intensively managed permanent grassland



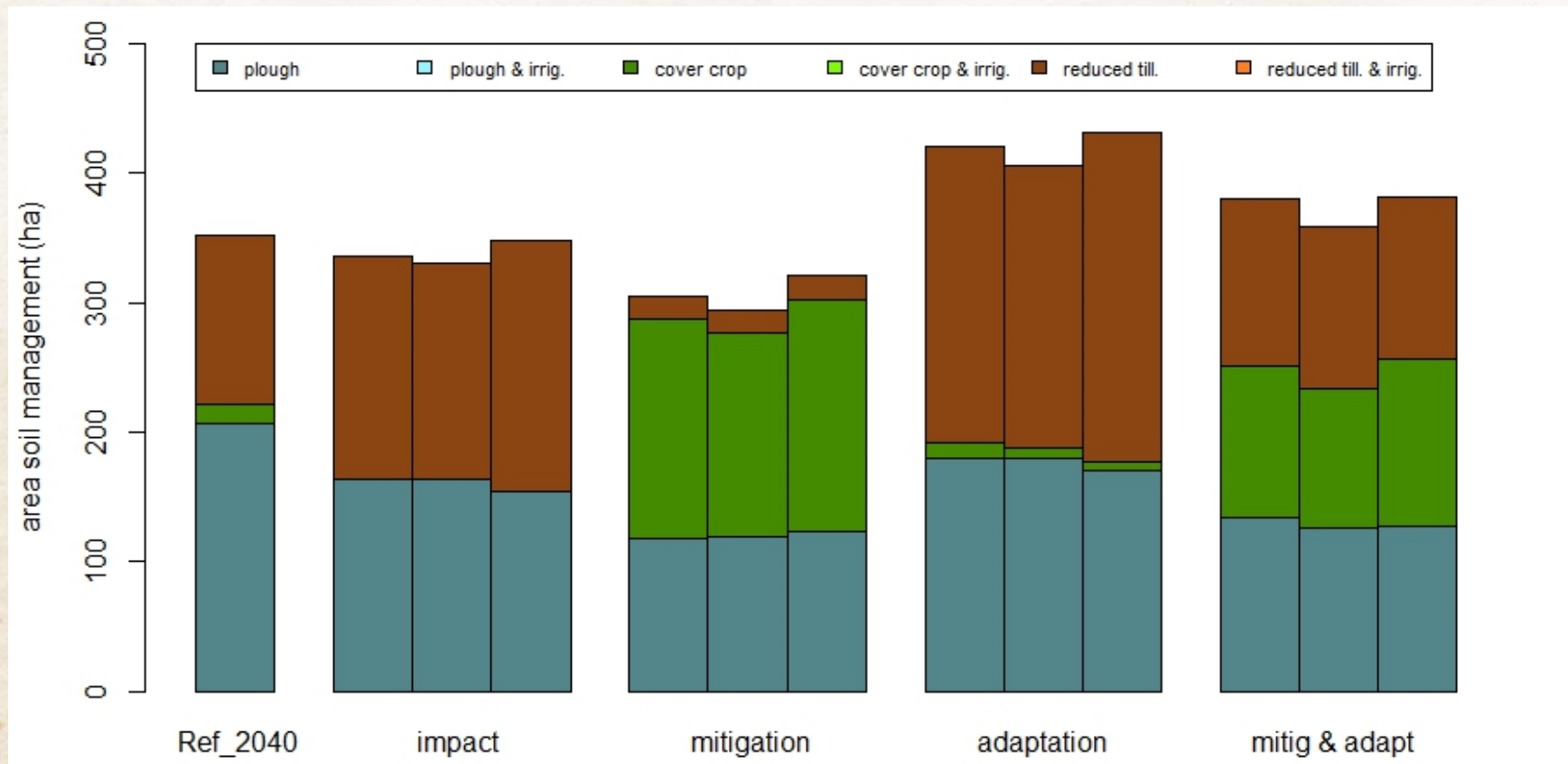
Orchard meadows



Forests

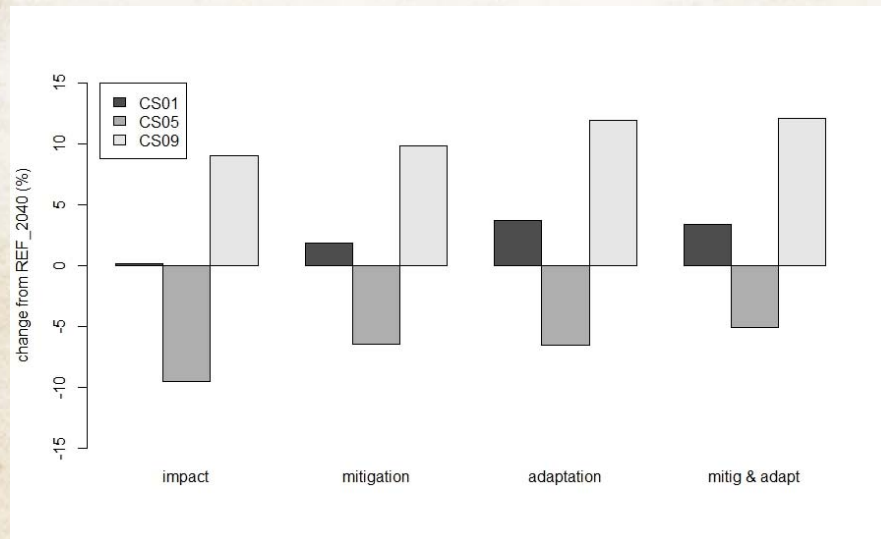


Prelim. Results – soil management (ha)

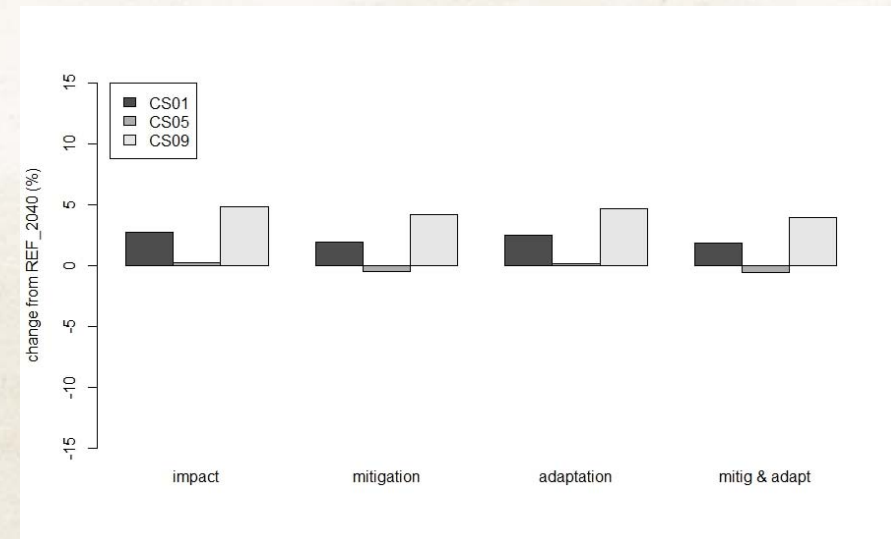


Prelim. Results – changes in soil organic carbon from climate change and policies

Cropland

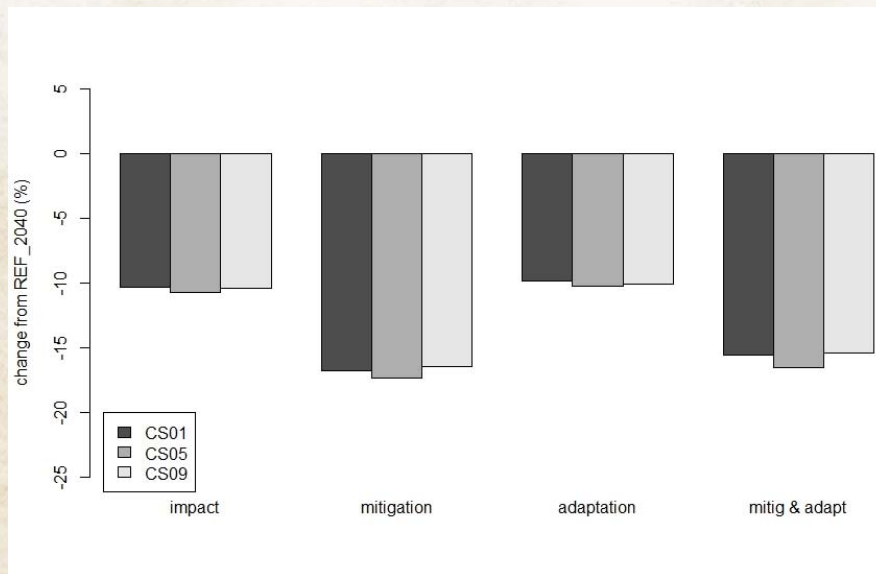


Permanent grassland

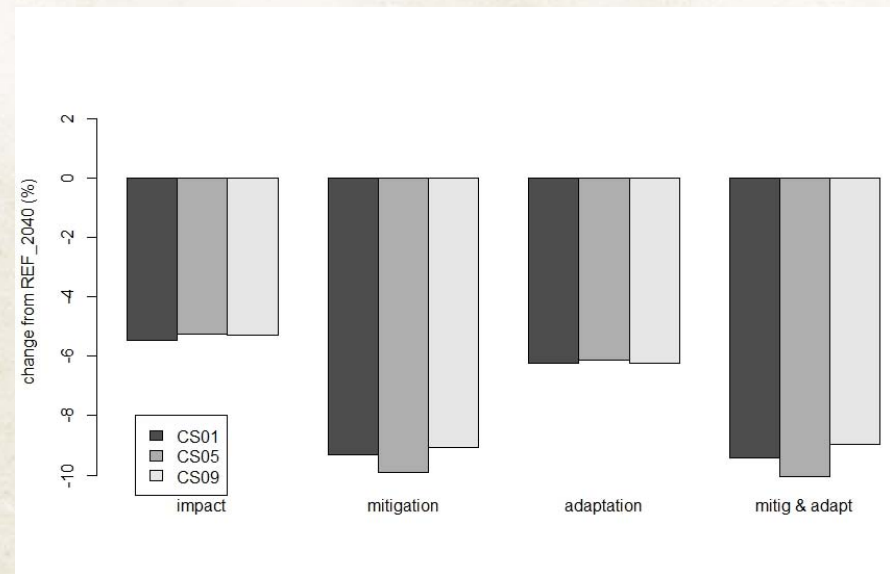


Prelim. Results – changes in nitrogen fertilization and GHG emissions from climate change and policies

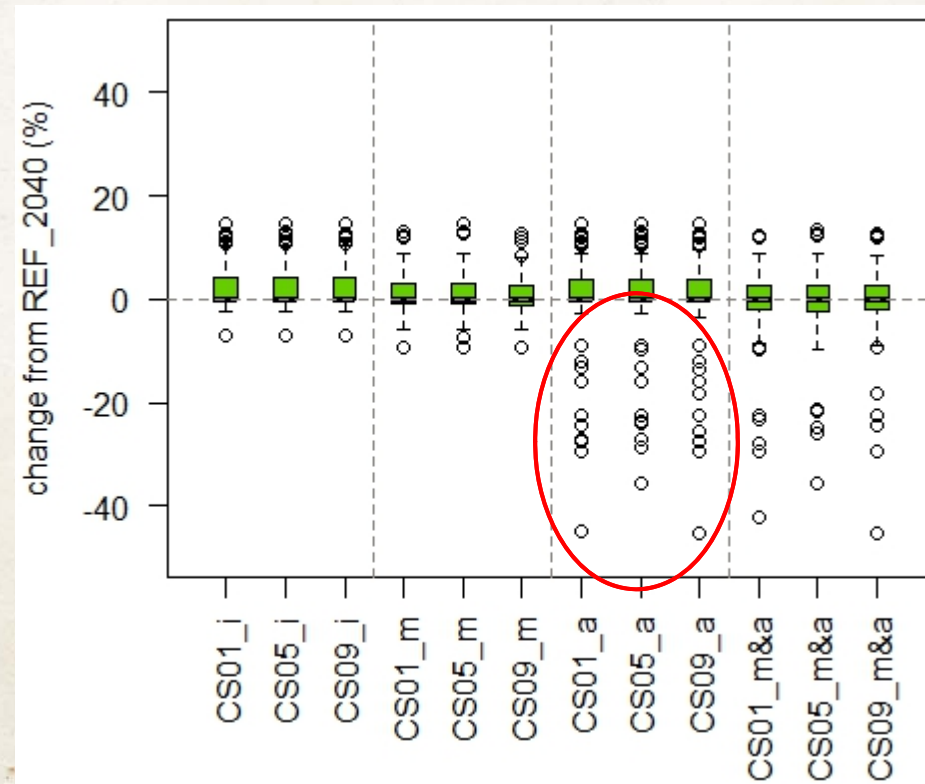
Nitrogen fertilization



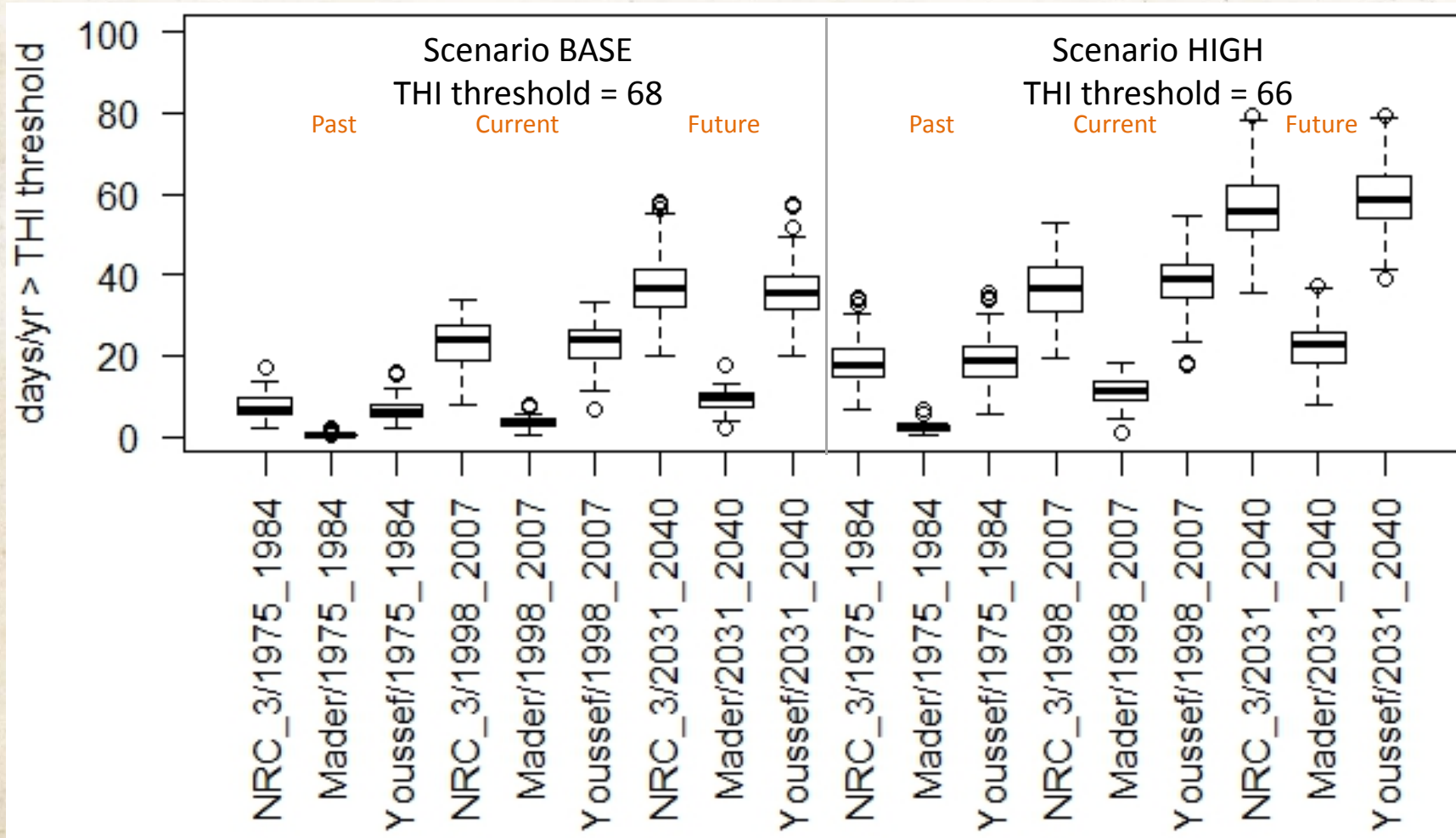
GHG emissions



Prelim. Results – changes in vascular plant species richness on farms from climate change and policies

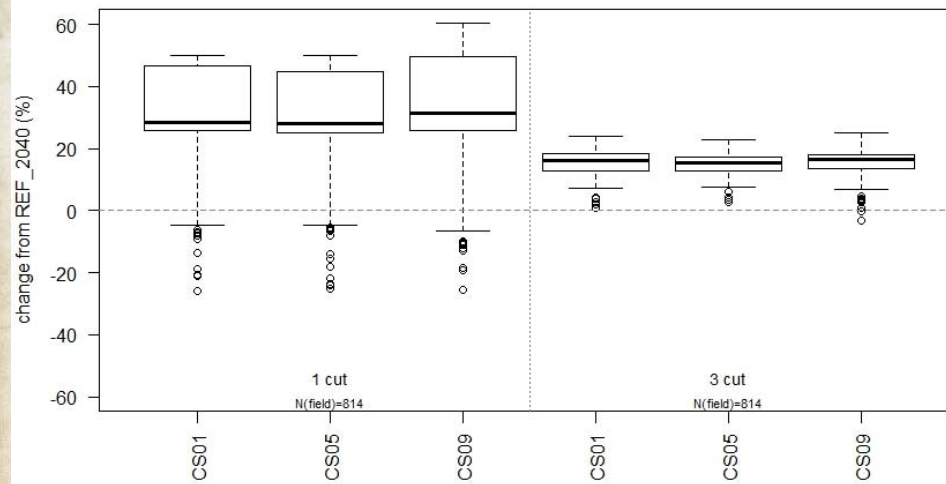


Days of THI values > threshold

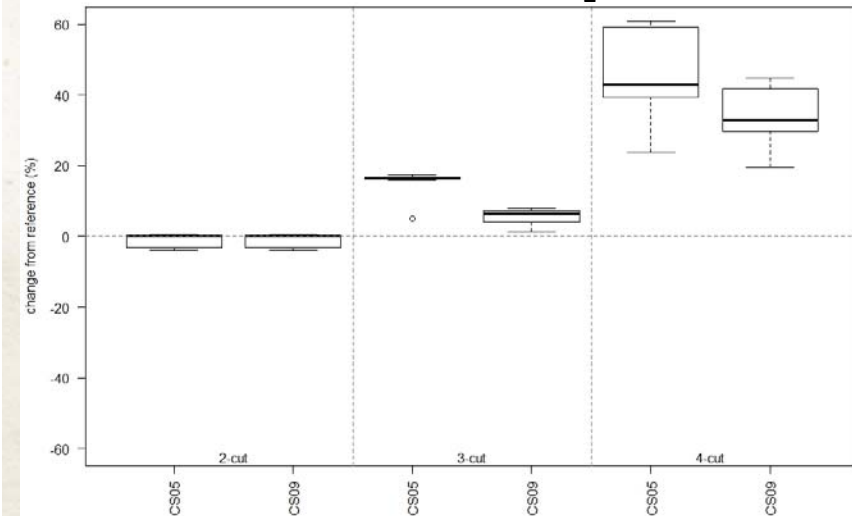


Model outputs on grassland yields

EPIC incl. CO₂-effect



Spatial GRAM excl. CO₂-effect



Discussion & Conclusions

- Increasing productivity from climate change on average
 - Consistent with literature
 - Some extremes not considered
 - Decreasing intensity on grassland counter-intuitive: model rigidity?
- Increasing farm incomes from policies on average
 - Mitigation: environmental quality, public cost, less production
 - Flexibility from adaptation: environmental trade-offs
- Heat stress: likely no issue in this region
- Location determines impacts
 - Heterogeneity among regions and farms
 - Not only latitude but altitude to be considered
- High spatial and system resolution offers interfaces



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