Modelling European Agriculture with Climate Change for Food Security

Uncertainty analysis and management in the regional pilot case study 'Mostviertel region'

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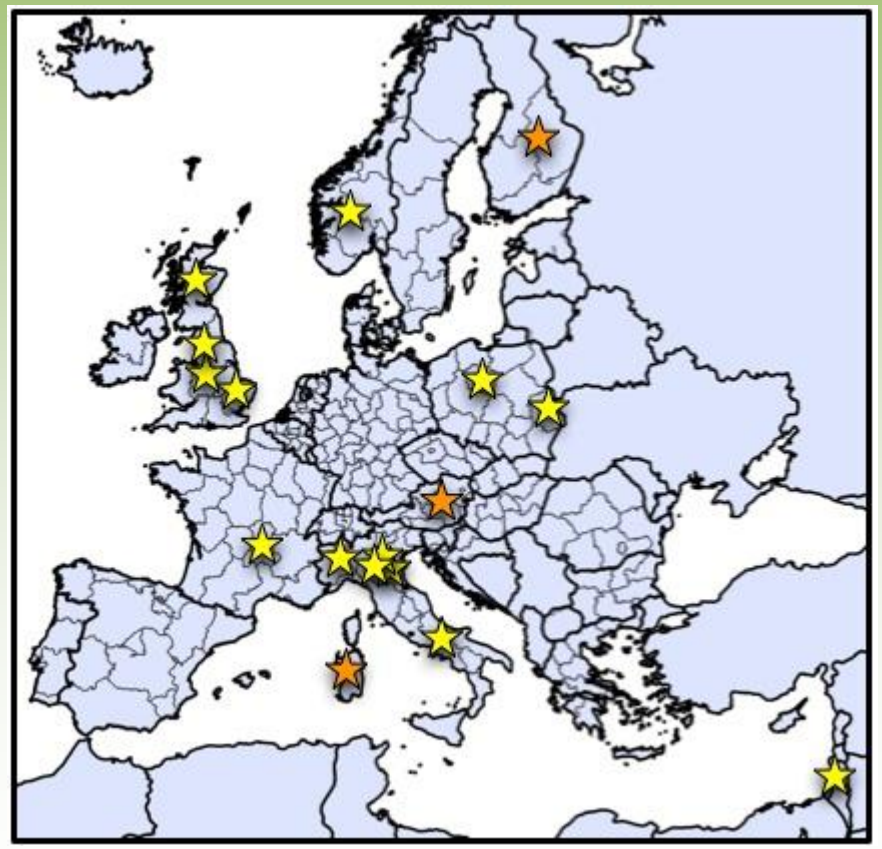
Mostviertel region



One of three MACSUR
Pilot Case Study Regions

Two landscapes, 1,500 ha each
231 farms

www.macsur.eu/index.php/regional-case-studies/






Methods and Data

Input

natural & socio-economic data

CAPRI

- 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

CropRota[1]

EPIC[2]

FAMOS[space][3]

Output

- socio-economic & RD indicators
- agri-environmental indicators
- food production indicators

[1]Schönhart et al. (2011). Eur J Agron 34, 263-277.
[2]e.g. Izaurralde et al. (2006). Ecol Modell 192, 362-384.
[3]Schönhart et al. (2011). J Environ Plann Manage 54, 115-143.

Uncertainty …

… climate projections (scenarios)

… bio-physical impact modelling

… economic land use modelling

… results communication and interpretation

Climate scenarios

Statistical climate model (Strauss et al., 2012, 2013a, 2013b)

- Linear regression with repeated bootstrapping
- Consistent spatial, temporal and physical correlation between 6 weather parameters; modelling of weather extremes (Strauss et al., 2013b)
- Projections into the future
  - Only valid in the medium term
- Significant temperature trend +2° C in 2050
- No significant precipitation pattern
  - 3 plausible precipitation scenarios: observation, +/- 20%
  - Allows sensitivity analysis on precipitation impacts

Crop modelling (I)

Bio-physical process model EPIC

- Applied at field level including soil, topography, and management (i.e. crop rotations, tillage, irrigation, and fertilizer intensities)
- Uncertainty is related to
  - Climate signals and residuals
  - Aggregation bias
  - Parameterization
  - Model structure

Crop modelling (II)

- Long standing experience in the region
- Face validation by researchers and stakeholders
- Lack of observed bio-physical data hampers uncertainty analysis at high spatial resolution, but …
  - … high spatial resolution reduces aggregation bias
  - … sensitivity analysis possible (e.g. CO_2 fertilization effect)
  - … ensembles: comparison to statistical grassland model and eventually grass land experiments (LiveM)
  - … relative changes transmitted to economic land use model if possible
  - … presentation only of relative changes

Land use modelling (I)

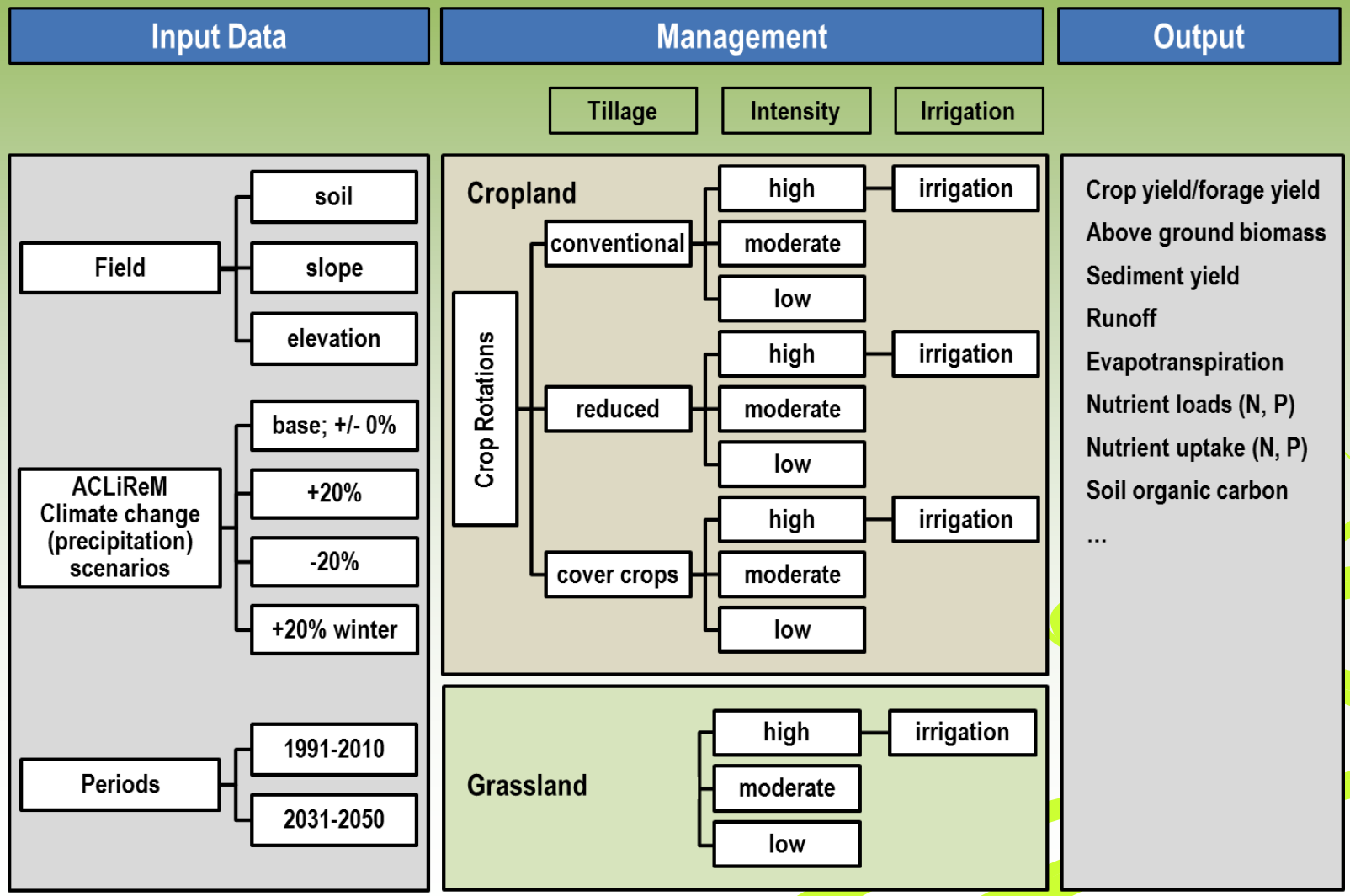
Bio-economic farm optimization model FAMOS[space]

- Maximizes farm gross margins subject to resource endowments and other constraints
- Uncertainty is related to
  - Bio-physical crop model inputs
  - Policy scenarios
  - Parameterization (e.g. economic input data)
  - Model structure
- Challenge for farm models: ensembles hardly possible but
- Large value of model structure comparison

Land use modelling (II)

- Policy scenarios should represent realistic pathways (stakeholder integration)
- High spatial resolution (e.g. costs from field size and distance to farm), but lacking farm interaction
- Availability of management alternatives for adaptation is crucial (e.g. crop rotations and cultivars)
- Constraints related to observed values (e.g. crop mixes) vs. calibration (e.g. PMP)
- Uncertainty analysis should include…
  - … comparison of model behavior to observations
  - … sensitivity analysis (Monte Carlo simulations)

EPIC – model run settings

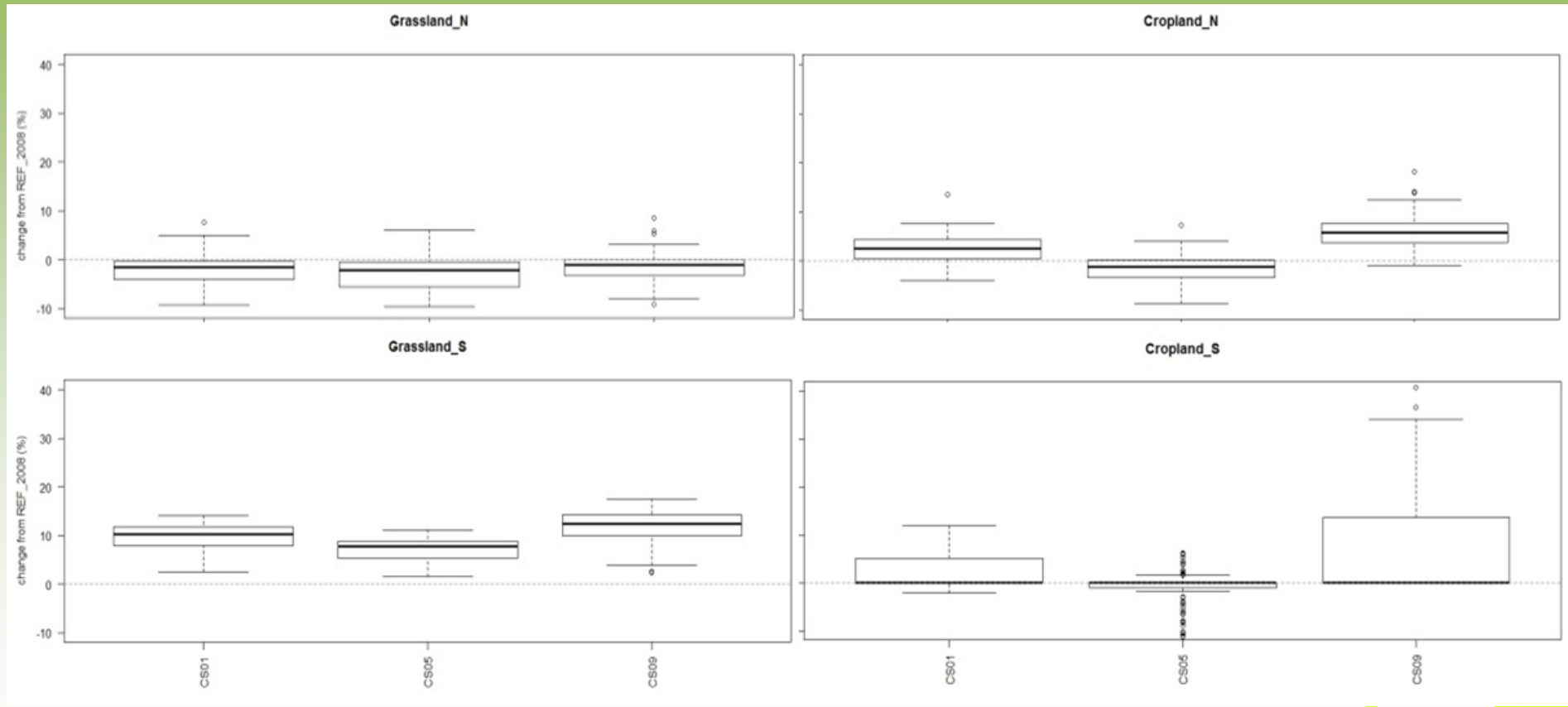


Expert Survey

- Survey on observed and expected climate change impacts and adaptation measures
- Dec-Feb 2014
- 17 experts (extension services, administration, farmers, policy makers)
- Respondents: 8
- Supports definition of adaptation measures

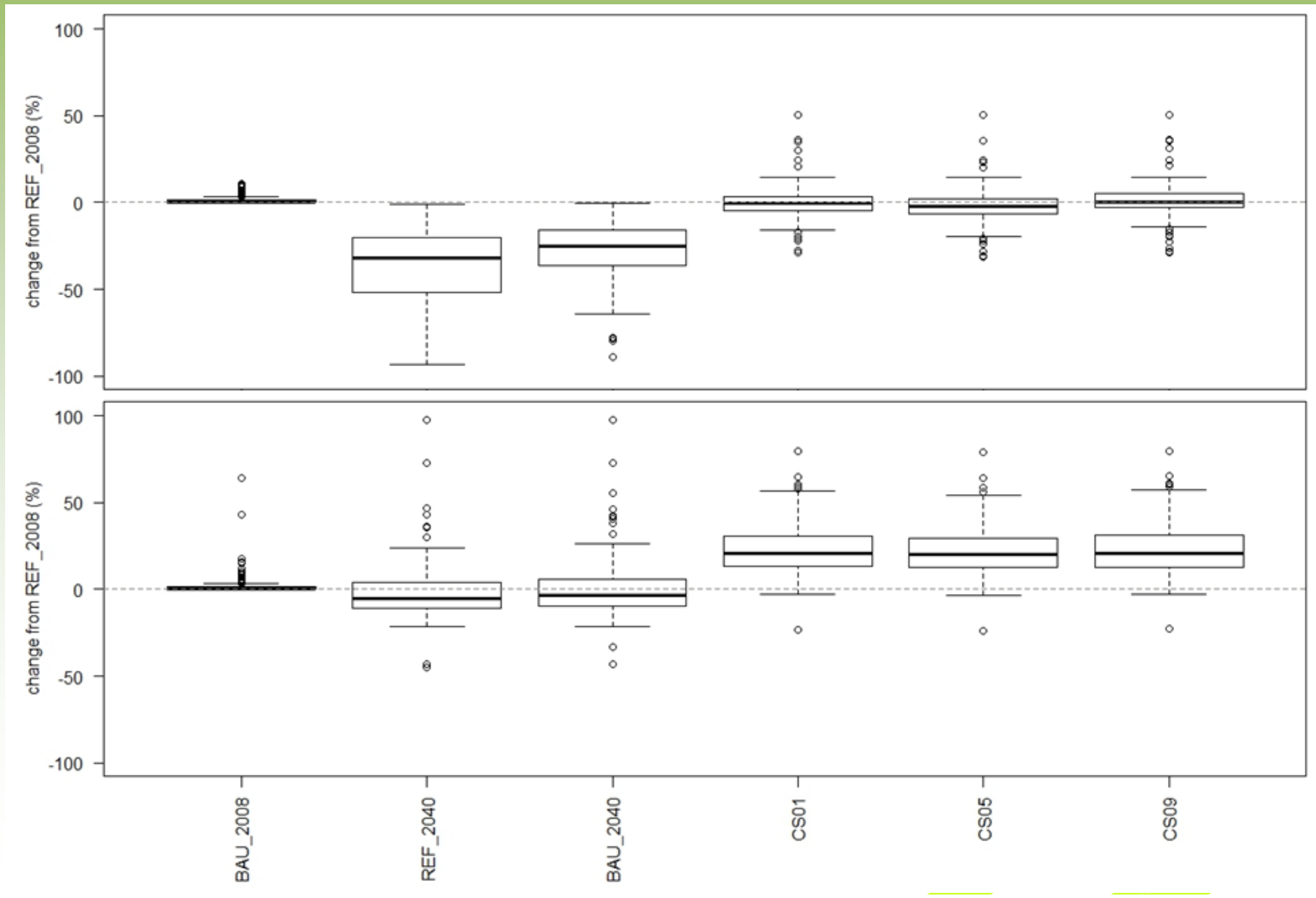
prelim. results –yield changes

1991-2010/2031-2050



Changes from REF_2008 on the farms (N_{north}=113, N_{south}=118) for grassland (left) and cropland (right) for the northern (N, above) and southern (S, below) case study landscape.

prelim. results –changes in total gross margins 1991-2010/2031-2050



Changes in total farm gross margin from REF_2008 for three socio-economic and three climate scenarios (upper graph: N_{north}=113, lower graph: N_{south}=118; scenario)







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