Trade-offs and synergies between agro-ecosystem functions in climate change adaptation planning

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Background

Climate impact assessments conducted in the study region in Western Switzerland suggest that with climate change agricultural productivity may decrease, while soil loss, nitrate leaching and water use for irrigation increase. Adaptation will be required to prevent these negative impacts.

Method

We apply a multi-objective regional optimisation approach to systematically explore the possibilities of adaptation through changes in agricultural management (Fig. 1).

A series of optimum trade-offs solutions is generated assuming different prioritisations of landscape functions: productivity, soil protection, nutrient cycling, water regulation. Results help to unravel complex trade-offs and synergies between different landscape functions and can thus support decision making in adaptation planning.

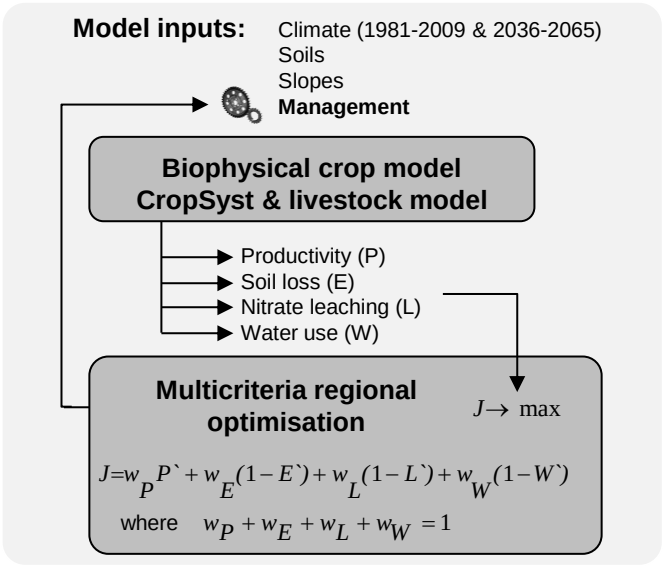

Figure 1: Regional optimisation integrates a biophysical crop model and a livestock model; it is applied to generate 258 Pareto-optimal solutions by systematically varying weights.

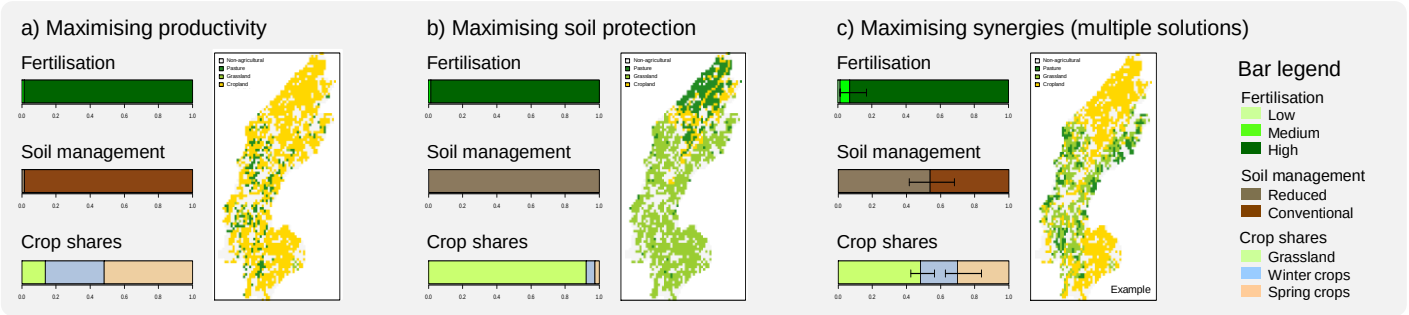

Figure 2: Adaptation possibilities derived from selected Pareto-optimal solutions achieving maximum trade-offs and synergies.

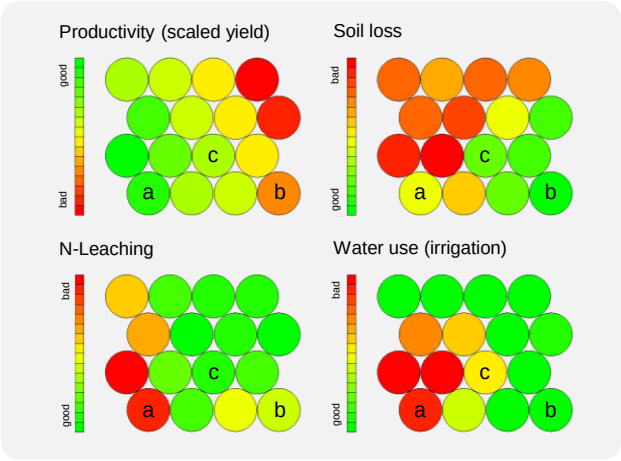

Figure 3: Synergies and trade-offs in Pareto-optimal solutions visualised in SOM (self-organising map): circles indicate values of clustered solution groups derived from the 258 solution (stars indicate approximate location of solutions shown in Fig. 2a-c: (a) maximising productivity, (b) maximising soil protection, (c) maximising synergies).

Case study results

There is a large scope for adaptation through changes in land use pattern and management. Adaptation planning should opt for solutions with maximum synergies between different landscape functions (Fig. 2,3).

Adaptation recommendations

- Reduce soil management to minimize soil loss and N-leaching
- Increase grassland and winter crop share to achieve good productivity with minimum soil loss and water use
- Increase irrigation to reduce production risk for spring crops

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