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Agroscope

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Impact analysis of land management scenarios on ecosystem services using SWAT

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FACCEJPI
biodiversa
FNSNF Swiss National Science Foundation
Soil as a Resource
National Research Programme NRP 68

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Background

We get benefits from ecosystem services:

- Food

Reference: livestrong.com

Background

We get benefits from ecosystem services:

- Food
- Fodder

Reference: freestockphotos.biz

Background

We get benefits from ecosystem services:

- Food
- Fodder
- Clean water …

Reference: cleanwater.news

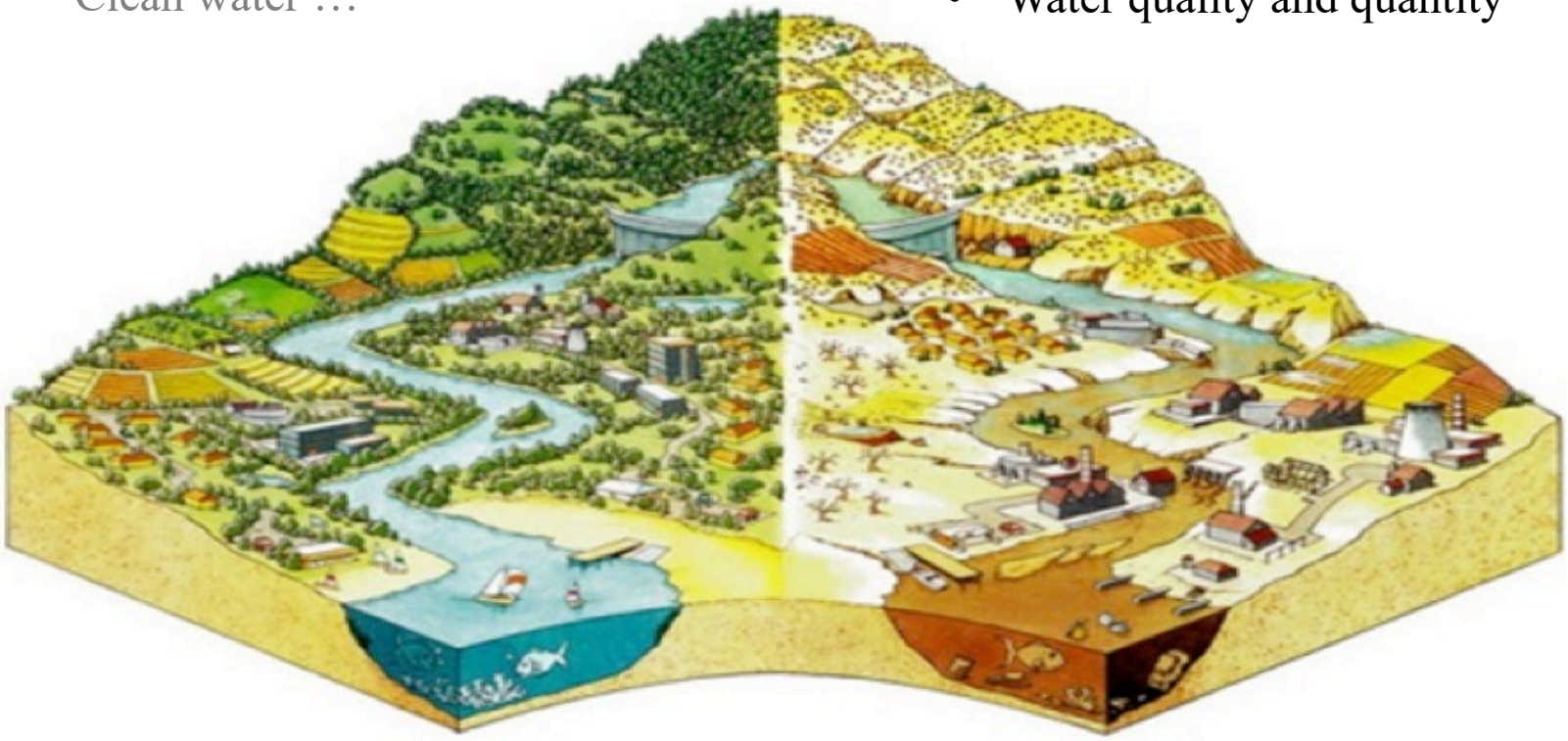
Background

We get benefits from ecosystem services:

- Food
- Fodder
- Clean water …

We cause problems:

- Nutrient leaching
- Soil loss
- Water quality and quantity



Reference: catchmentguidelines.org.mw

The overall project TALE

- Towards multifunctional agricultural landscapes in Europe (TALE): Assessing and governing synergies between food production, biodiversity, and ecosystem services

- How can land management be improved to provide better synergies?

Swiss case study: Broye catchment

Research questions

- What is the current status of ecosystem services in the study area? What are the main conflicts between them?

- What are the potentials of land management scenarios to reduce conflicts between different ecosystem services?

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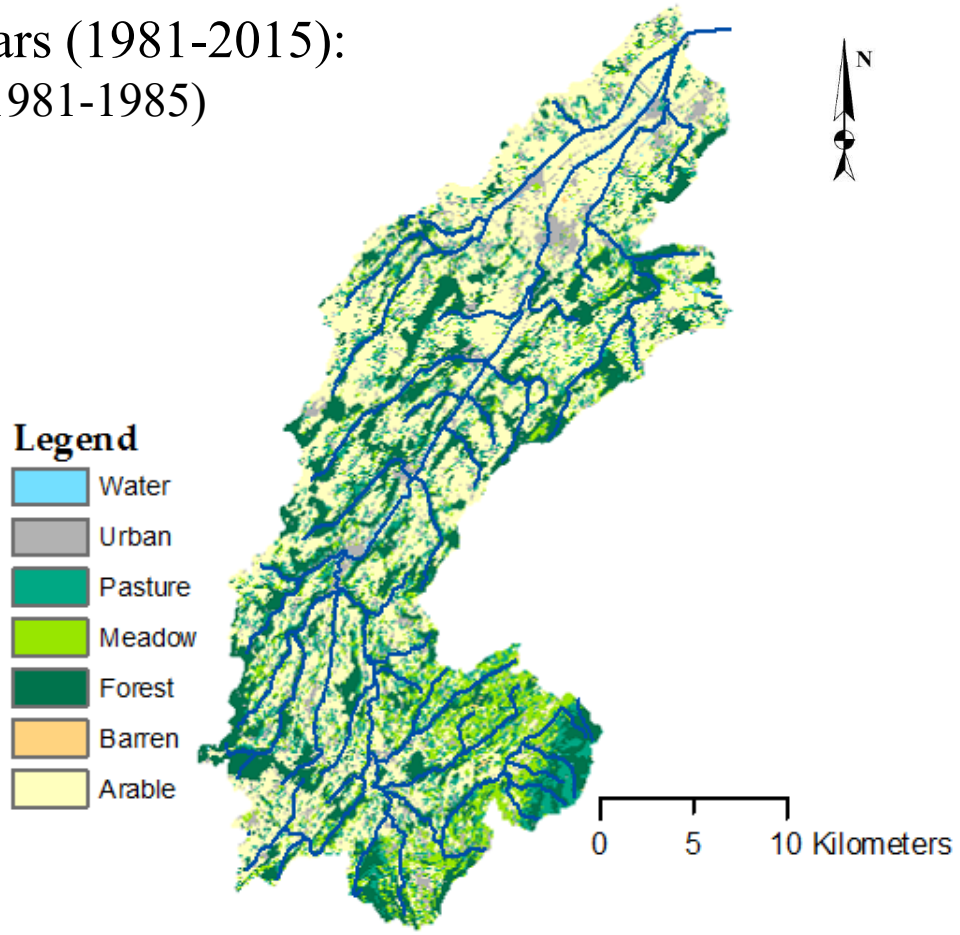
- What are the potentials of land management scenarios (land sparing vs. land sharing) to reduce conflicts between different ecosystem services?

Ecosystem services	**Indicator**
Water quantity regulations	Low flow [m^3 /s], defined as 5^{th} percentile of daily river discharge for the entire period.
Water quality regulation	Yearly nitrate concentration [mg N/l] in the outlet of the catchment
Erosion regulation	Yearly transported sediment [t/ha]
Food provision	Agricultural benefit [Mio CHF/year] = benefit from crop & mild production – applied fertilizer cost
Climate regulation	Greenhouse gas (GHG) emissions [CO_2 equivalent kt/year]

SWAT model

SWAT model setup for 35 years (1981-2015):

- 5 years for warm up period (1981-1985)
- 18 years for calibration
- 12 years for validation



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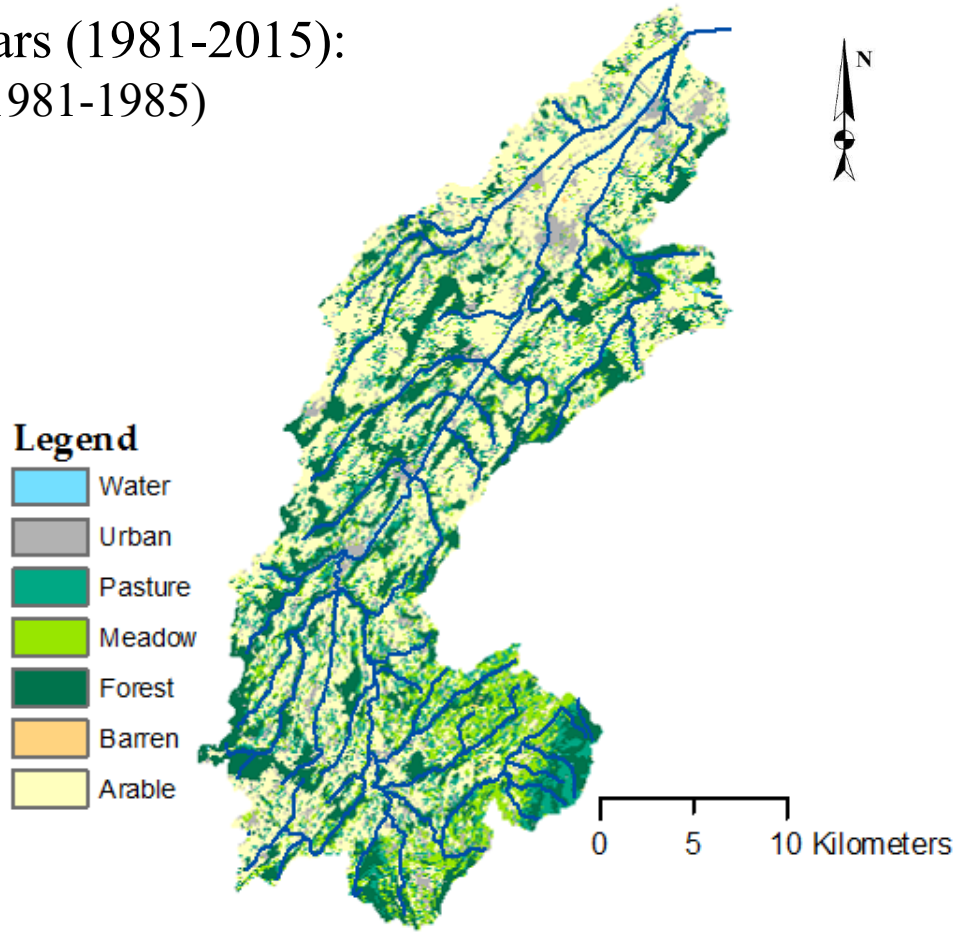
SWAT is calibrated by an iterative way with Swat-cup and R in 2 steps :
First water quantity (daily river discharge and low flow) and then water quality (monthly nitrate)



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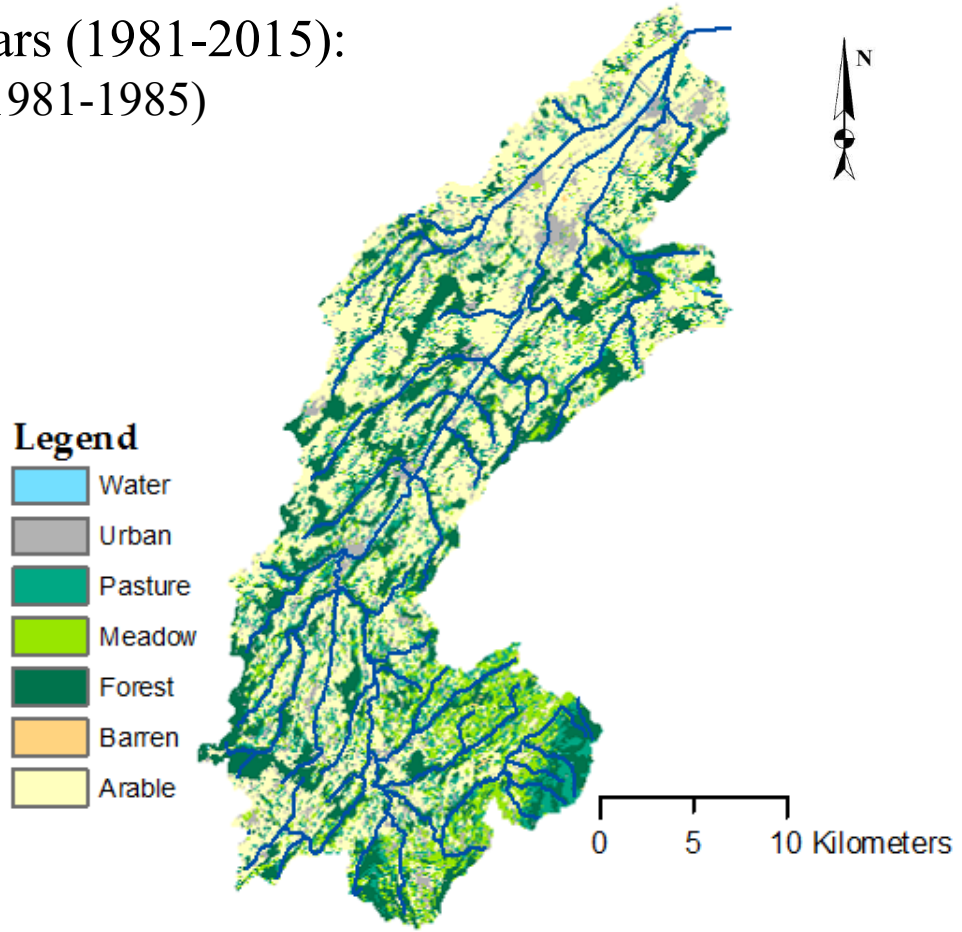
233 sets of parameters are selected for generating land management scenarios' results



Land sharing vs land sparing

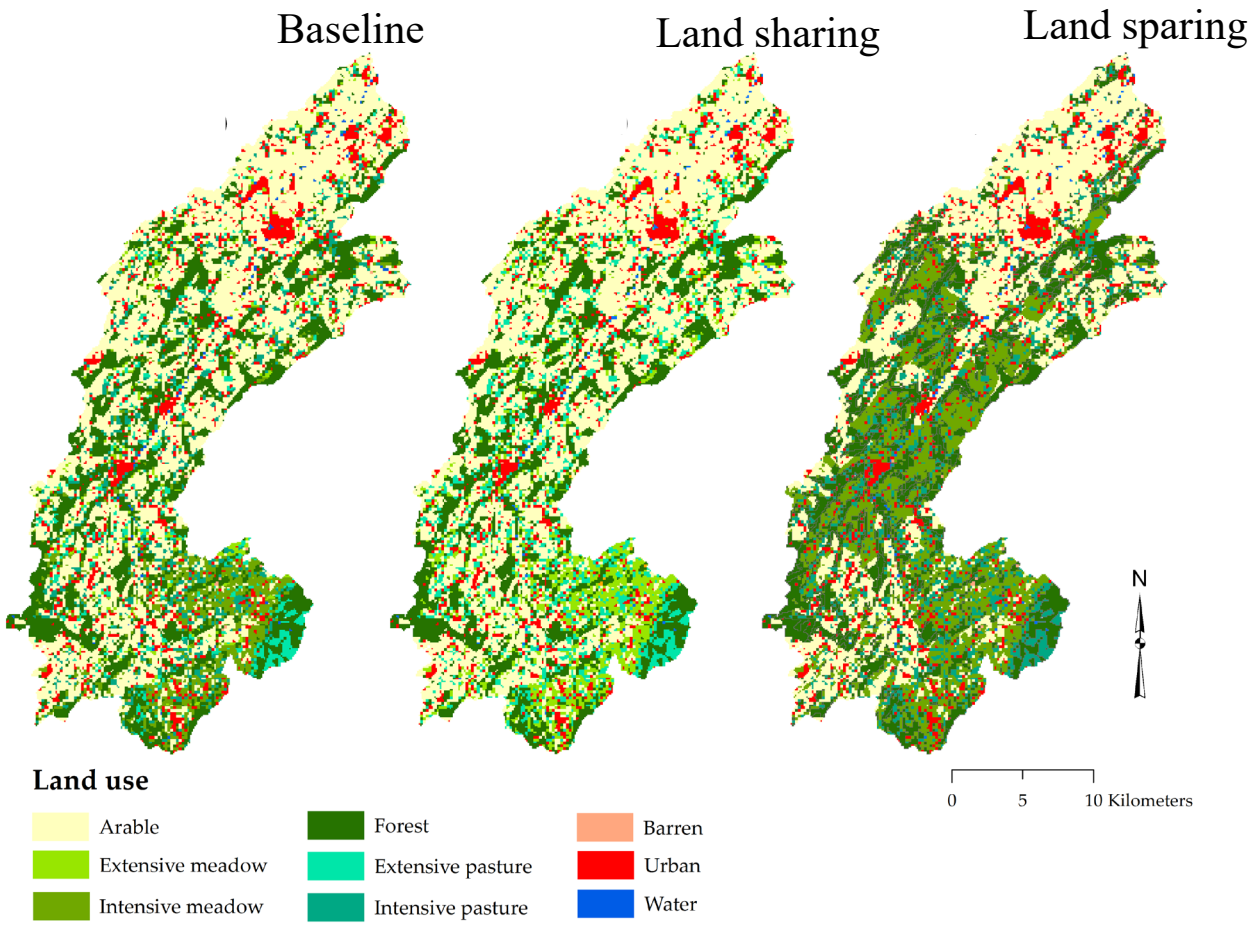
Land sparing — Baseline (i.e. actual) — Land sharing

- Unlimited irrigation in lowlands
- Intensification: all permanent grassland transformed to intensive, increase of potato, increasing fertilizer by 25%
- Transforming arable areas on steep slope to intensive meadow
- Low fertile areas turned to the nature protection areas (forest)

- No irrigation
- Extensification: all permanent grasslands transformed to extensive, increase of ley and grain legumes within rotations

Results

Land management application results in SWAT model inputs:



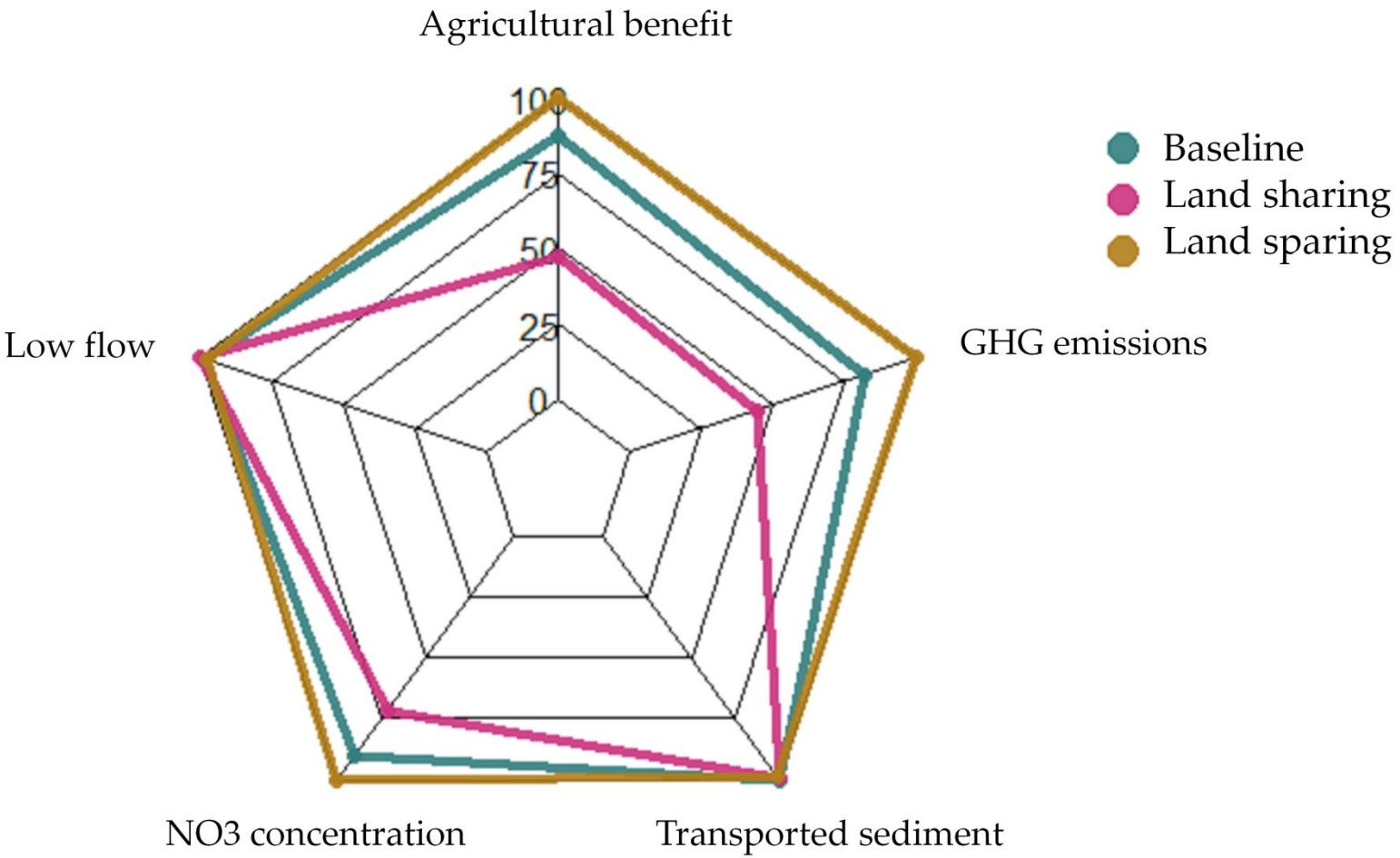
Results

Land management application results in SWAT model inputs:

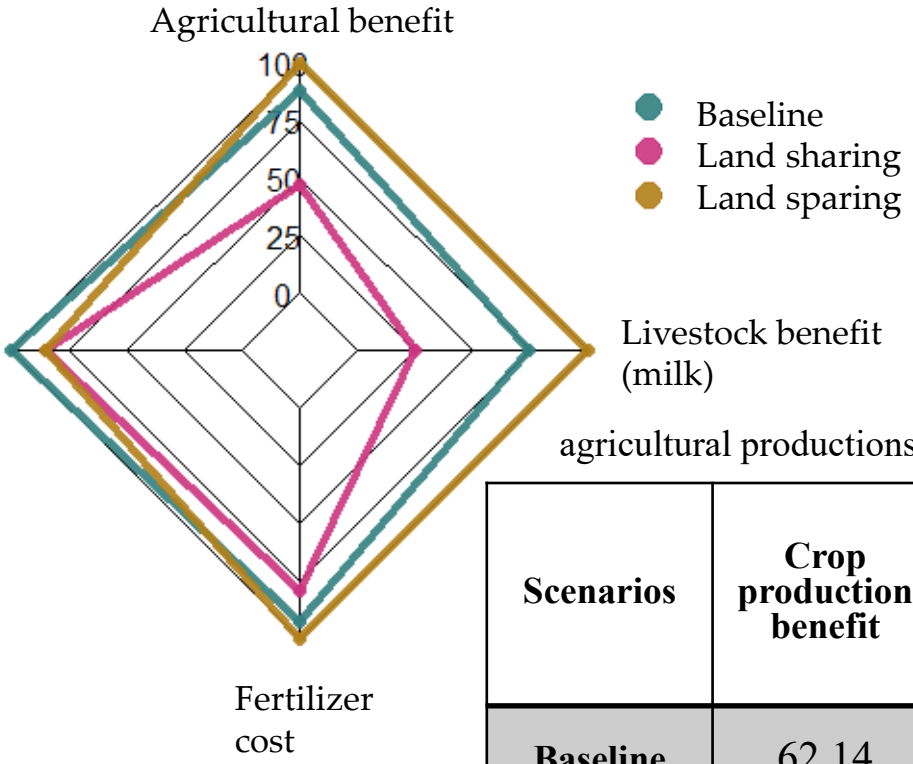
Different land use areas [ha] in different land management scenarios

Land use	**Land management**	**Baseline**	**Land sharing**	**Land sparing**
Permanent grasslands (Pasture and meadow)	Intensive	9184	0	20007
	Extensive	3678	12862	0
Arable	Total arable area	29576	29576	20178
	Potato	1506	1252	2281 (+6%)
	Field pea	1791	3190 (+5%)	1143
	Temporary ley	8254	10219 (+7%)	5257
	Irrigated arable area	1130 (4%)	0	6096 (30%)
Forest	---	14635	14635	16889

Results


Agricultural benefit
100
75
50
25
0
Low flow
GHG emissions
NO3 concentration
Transported sediment
Baseline
Land sharing
Land sparing

Results

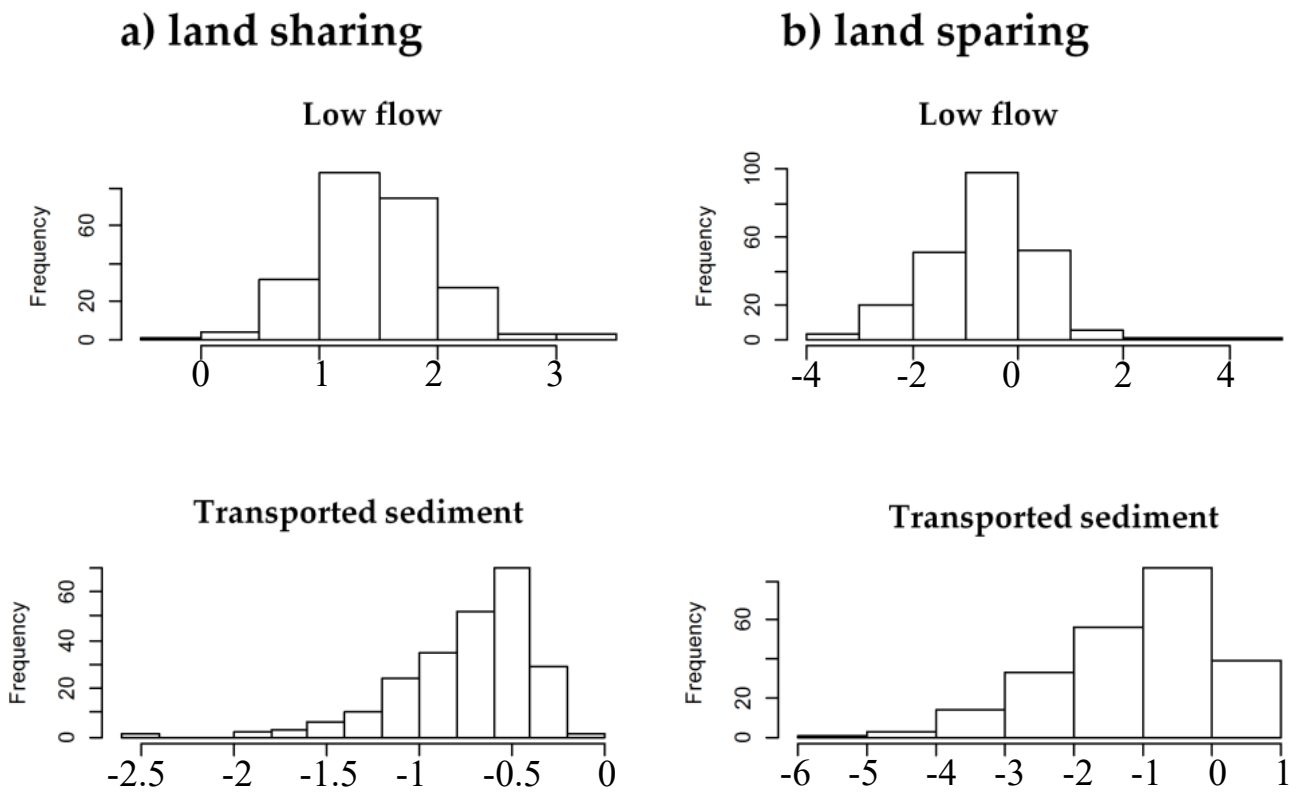


agricultural productions [Mio CHF/year] for the three scenarios:

Scenarios	Crop production benefit	Applied fertilizer cost	Livestock benefit	Total benefit
Baseline	62.14	5.49	86.83	143.48
Land sharing	52.59	4.71	29.24	77.12
Land sparing	52.74	5.97	116.98	163.75

Results

Impact of parameters uncertainty in land management studies



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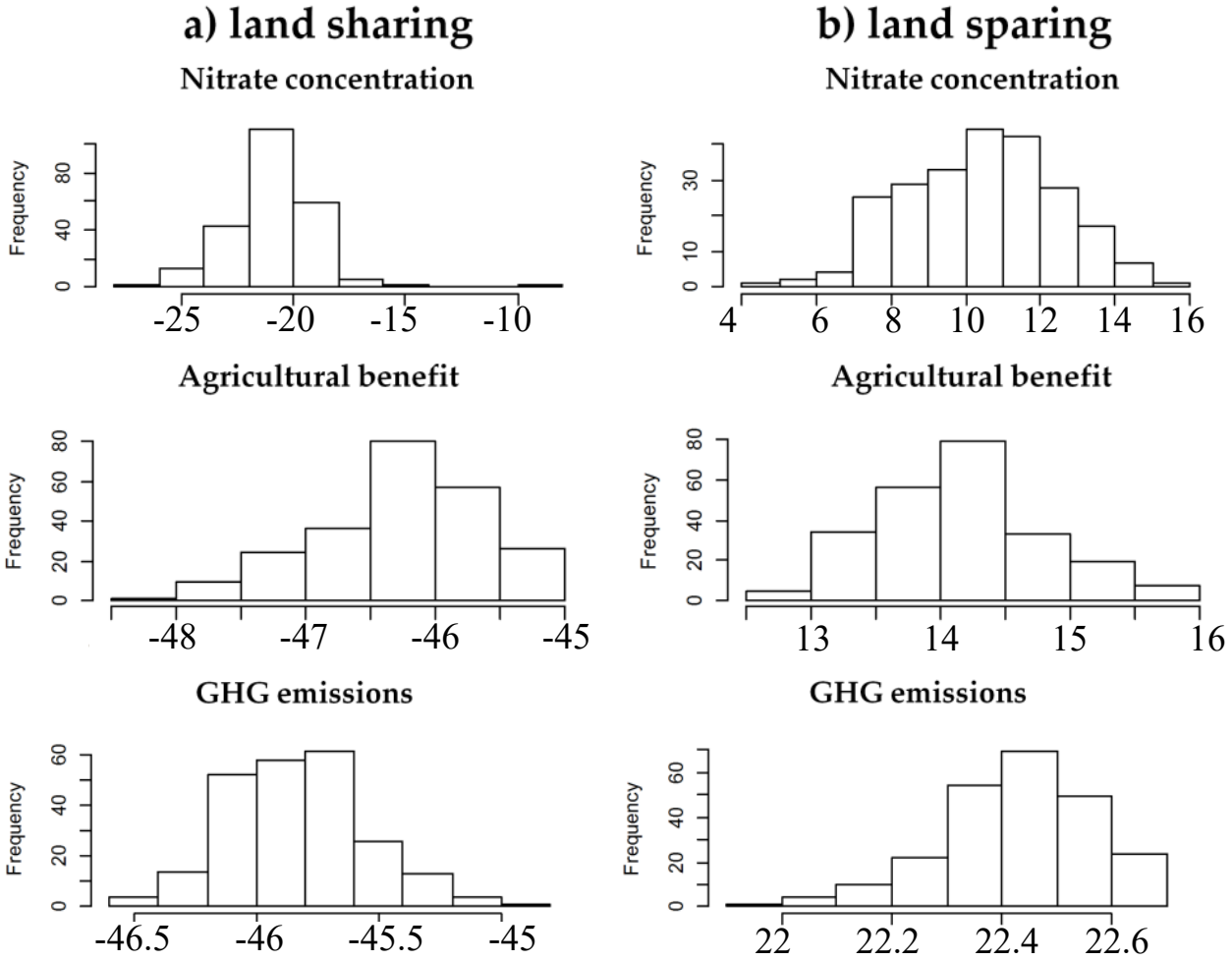

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Conclusion

- **Main conflict/trade-off in the case study:** benefits from agricultural production are in conflict with diffuse pollution and greenhouse gas emissions.
- None of the investigated scenarios could **reduce** the dominant land use conflict in general, but only induce a **shift** in trade-offs.
- Land sparing is the least preferable according to stakeholders; and baseline and land sharing scenarios are more preferable.

Thanks & question?

Reference: diariesofmagazine.com