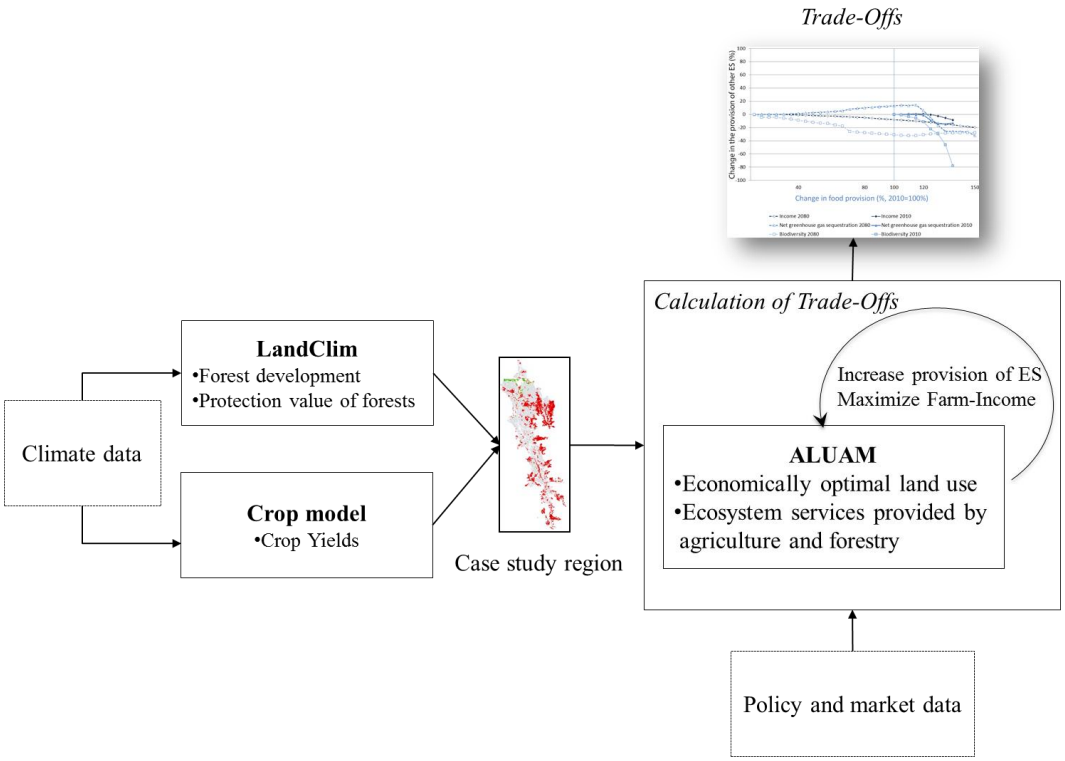
Appendix 1. Characteristics of ALUAM

Interaction of submodels

Fig. A1.1. Interaction between the different submodels in the Alpine Land Use Allocation Model



The assessment of changes in land-use and EGS is accomplished in two steps (Fig.1). In step one, the direct impacts of climate change on forest development and crop yields are calculated for each year between 2010 and 2080. This step involves amalgamating three data sources: (1) Within each simulated parcel (100 m x 100 m) the potential yield of all agricultural and forestry activities (for an overview see Table 2) is simulated by the forest-simulation model LandClim and the crop yield model. (2) Spatially explicit data are calculated for each parcel. A digital elevation model is used to calculate elevation and slope of each parcel. Swiss Land Cover Statistics are used to determine which parcels are suitable for cultivation and a soil utility map is used to rate the different parcels according to their suitability for the land-use activities. Swiss Land Cover Statistics was used to calculate the distance of all parcels to the next farm. (3) Administrative data, e.g. the production zone the parcel is lying in, are assigned to the parcels. In step two, these spatially explicit yield estimates are combined with policy and market scenarios in the economic model Alpine Land Use Allocation Model (ALUAM). ALUAM then simulates land-use decisions based on a profit maximizing approach. The results show both where land-use change occurs and what the combined impact of climate and economic change is. The data assigned to each parcel is thus combined with sources linking spatially explicit data with production parameters such as labor demand, nutrient demand, fodder production and the transport costs dependent on the distance between parcel and farmyard (Briner et al. 2012).

Reference

Briner, S., C. Elkin, R. Huber, and A. Grêt-Regamey. 2012. Assessing the impacts of economic and climate changes on land-use in mountain regions: a spatial dynamic modeling approach. *Agriculture, Ecosystems & Environment* 149:50-63. http://dx.doi.org/10.1016/j.agee.2011.12.011

Land use activities in the Alpine Land Use Allocation Model (ALUAM)

Table A1.1. Land use activities as implemented in the ALUAM model

	Intensity		
	intensive	mid-intensive	extensive
Hay meadow	x	x	x
Grazed pasture	x		x
Wheat		x	
Barley		x	
Potato		x	
Sugar beet		x	
Maize		x	
Forest	Maintenance incl. wood harvest		Maintenance without wood harvest
Fallow		--	

Calculation of GHG emissions

Table A1.2. References of methods applied in ALUAM to calculate on-farm greenhouse gas (GHG) emissions

GHG	Emission Source	Influencing factor	Reference
CH_4	Enteric fermentation	Number of animals, Animal-specific methane rate, feed mix, lipid supplementation	IPCC 2000, Minonzio et al. 1998
	Manure	Amount of different manures, feed mix, housing system, pasture management	
N_2O	Manure	Amount of different types of manure, manure management	IPCC 2000, Schmid et al. 2000, 2001
	Land-use	Fertilizer	
	Indirect emission	Loss of N in different compounds	Schmid et al. 2000
CO_2	Tractor/Machinery	Land-use intensity	Gazzarin and Albisser Vögeli 2010

References

Minonzio, G., A. Grub, and J. Fuhrer. 1998. *Methan-Emissionen der schweizerischen Landwirtschaft*. Schriftenreihe Umwelt Nr. 298. Bundesamt für Umwelt, Wald und Landschaft (BUWAL), Bern.

IPCC, 2000. *Emissions Scenarios - Summary for Policymakers. A Special Report of IPCC Working Group III*, Intergovernmental Panel on Climate Change.

Schmid, M., Neftel, A., Fuhrer, J., 2000. *Lachgasemissionen aus der Schweizer Landwirtschaft*. Schriftenreihe der FAL 33. Eidgenössische Forschungsanstalt für Agrarökologie und Landbau, FAL Reckenholz, Zürich.

Schmid, M., Neftel, A., Riedo, M., Fuhrer, J., 2001. Process-based modelling of nitrous oxide emissions from different nitrogen sources in mown grassland. *Nutrient Cycling in Agroecosystems* 60: 177–187.

Gazzarin, C., Albisser Vögeli, G., 2010. *ART-Bericht –Maschinenkosten 2009/2010*. Agroscope Reckenholz Tänikon, Ettenhausen.

Scenario assumptions

Table A1.3. Economic scenarios applied in ALUAM (based on Briner et al. 2012)

	Unit	*EU 2005*[1]	2010	A1FI 2080
Milk	CHF/kg	*0.46*	0.75	0.24
Beef	CHF/kg CW	*4.7*	8.1	3.9
Lamb	CHF/kg CW	*5.5*	9.7	4.6
Wheat	CHF/t	*151*	503	51
Potato	CHF/t	*149*	407	76
Sugar beet	CHF/t	*61*	64	16
Barley	CHF/t	*149*	377	50
Rapeseed	CHF/t	*301*	760	81
Corn	CHF/t	*174*	379	113
Pesticides[3]	%		100	51
Machinery[3]	%		100	52
Fuel[3]	%		100	62
Seed[3]	%		100	179
Concentrate feed[2]	%		100	34

CHF: Swiss francs; t: tons ; CW: Carcass weight

[1] EU prices in 2005 were the base for the calculation of the prices in the future scenarios (Source: FOAG 2006).

[2] It was assumed that prices for concentrate feed behave as prices for cereals.

[3] Parameter derived directly from Abildtrup et al (2006)

References

Briner, S., C. Elkin, R. Huber, and A. Grêt-Regamey. 2012. Assessing the impacts of economic and climate changes on land-use in mountain regions: a spatial dynamic modeling approach. *Agriculture, Ecosystems & Environment* 149:50-63. http://dx.doi.org/10.1016/j.agee.2011.12.011

Abildtrup, J., E. Audsley, M. Fekete-Farkas, C. Giupponi, M. Gylling, P. Rosato, and M. Rounsevell. 2006. Socio-economic scenario development for the assessment of climate change impacts on agricultural land use: a pairwise comparison approach. *Environmental Science & Policy* 9:101-115.