A L P E S
ALPINE LANDSCAPES,
PASTORALISM AND ENVIRONMENT OF VAL DI SOLE
- ORTISÉ-MENAS | 2015 -

McCord
Centre for Landscape

LABORATORIO B.BAGOLINI
Archeologia preistorica, medievale e Geografia storica

Investigating historical subsistence and land-use strategies in mountain environments: the integration of computer simulation and ethnoarchaeological methods

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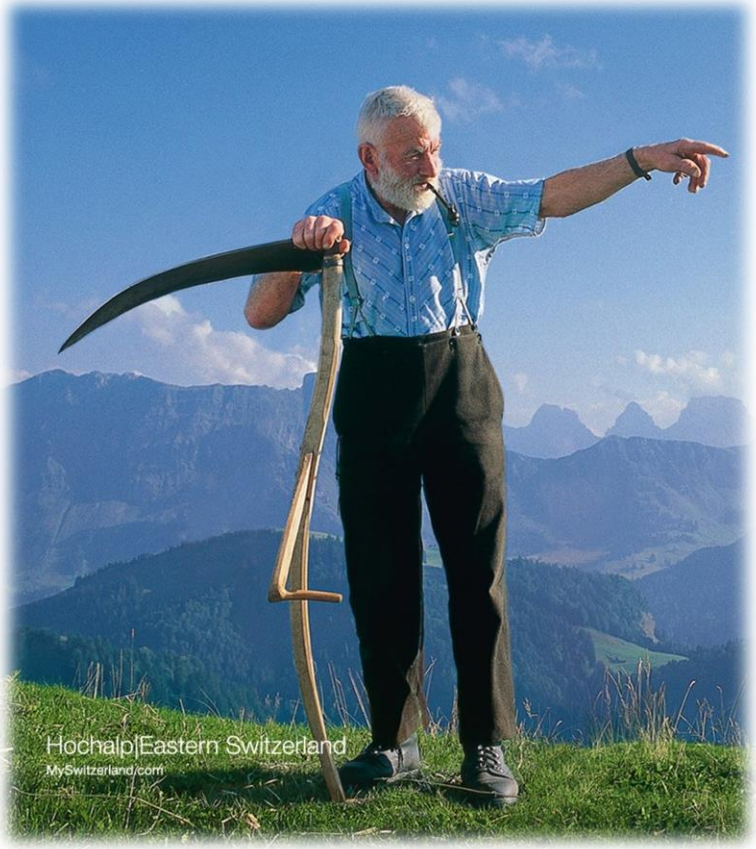
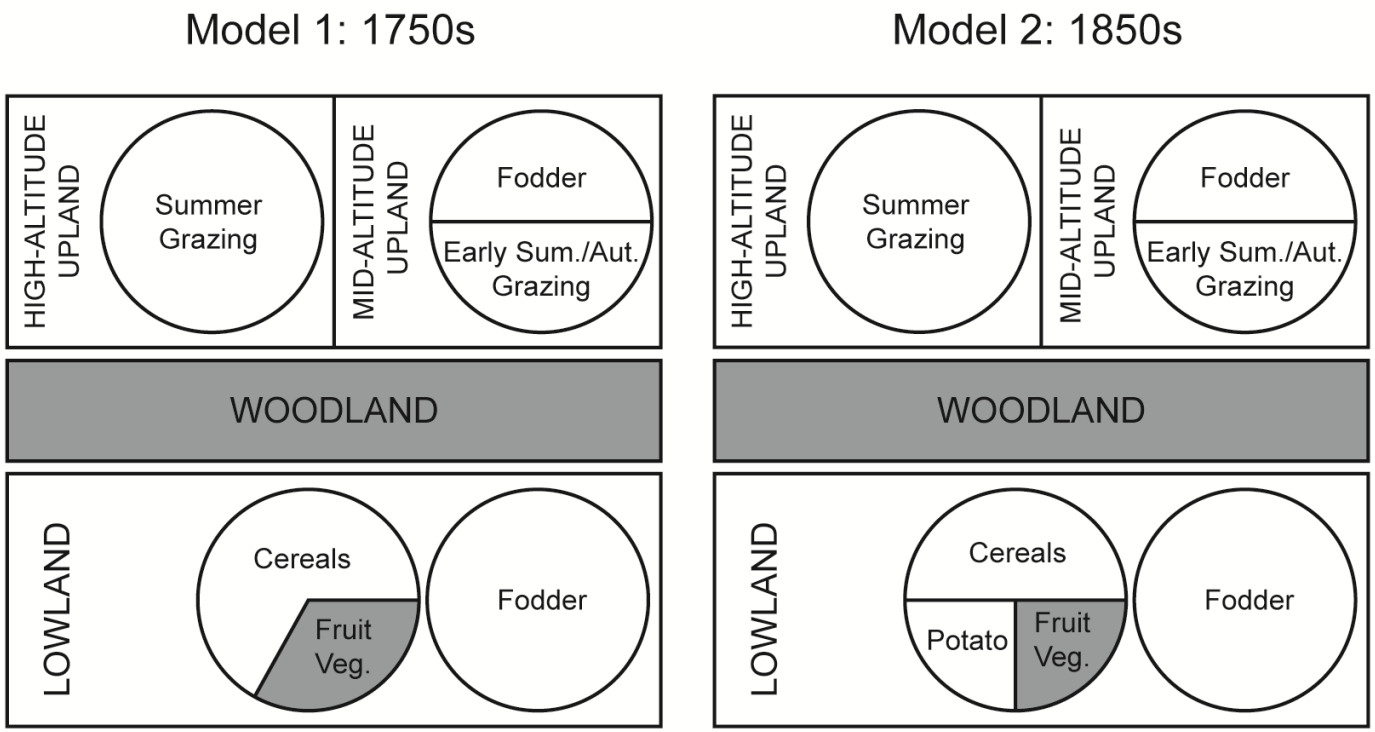
Modelling socio-ecological systems in the Alps



- Formalising the relationship between **human needs and pre-modern farming yields** in mountain environments
- Exploring the **role of seasonal resources in the subsistence** economy of pre-modern mountain communities
- Assessing the correlation between pre-modern **economic strategies and land-use** practices in mountain environments

The study-area: Ortisé and Menas (Val di Sole – Italy)

The structure of the model



Population:150 p. for 1750s and 300 p. for 1850s

1750s: mixed-crops; subsistence-focused sheep-based husbandry

1850s: introduced potatoes; dairy-focused cattle-based husbandry

1850s: larger portion of products for the market

Results and interpretation

For Materials & Methods and Discussion of simulation results, see:
Carrer F. et al. 2019. Ethnoarchaeology-Based Modelling to Investigate Economic Transformations and Land-Use Change in the Alpine Uplands. M. Saqalli, M. Vander Linden (eds.), *Integrating Qualitative and Social Science Factors in Archaeological Modelling*. Springer: 185-216.

- Simulation results for 1850s are remarkably similar to the actual land use of Ortisé and Menas described in the Habsburg **cadastre of 1857**
- The **increase** in the surface used for agricultural and pastoral activities in 1850s ranges between **40% (uplands) and 60% (lowlands)**, with a 100% population increase
- Rural economy during the 1850s might have been **more efficient** despite the intensification in animal
- Specialised dairy farming might have **decreased the resilience** of local communities, although the money acquired from cheese trading could have been reinvested in activities to **improve the productivity**

SUPPLEMENTARY 1: Simulation Parameters

CATEGORY	PARAMETER	NAME
Calorific fraction of diet	Cereal products	ϵ_g
	Domestic animal products	ϵ_d
	Wild animal products	ϵ_w
	Potatoes	ϵ_p
Domestic animals parameters	Fraction of cattle	a_c
	Fraction of sheep/goats	a_s
	Fraction of pigs	a_{pi}
	Usable meat: cattle (kg/hd)	m_c
	Usable meat: sheep/goat (kg/hd)	m_s
	Usable meat: pig (kg/hd)	m_{pi}
	Energy content: cattle (kcal/kg)	e_c
	Energy content: sheep/goat (kcal/kg)	e_s
	Energy content: pig (kcal/kg)	e_p
	Fraction of cattle culled annually	k_c
	Fraction of sheep/goat culled annually	k_s
	Fraction of pigs culled annually	k_{pi}
	Fraction of milking cows in a cattle herd	k_c
	Fraction of miling ewes/does in a flock	k_s
	Surplus cow milk after weaning (l/yr/hd)	y_c
	Surplus sheep/goat milk after weaning (l/yr/hd)	y_s
Grazing and foddering areas	Grazing area: cattle (ha/hd)	A_c
	Grazing area: sheep/goats (ha/hd)	A_s
	Grazing area: pigs (ha/hd)	A_p
	Area for winter fodder: cattle (ha/hd)	M_c
	Area for winter fodder: sheep/goats (ha/hd)	M_s
	Fraction of fodder as hay	$\aleph$

CATEGORY	PARAMETER	NAME
Wild animal products	Usable meat: red deer (kg/hd)	m_r
	Usable meat: roe deer (kg/hd)	m_{ro}
	Usable meat: wild boar (kg/hd)	m_b
	Usable meat: chamois (kg/hd)	m_{ch}
	Usable meat: ibex (kg/hd)	m_i
	Fraction of red deer among wild animals	a_r
	Fraction of roe deer among wild animals	a_{ro}
	Fraction of wild board among wild animals	a_b
	Fraction of chamois among wild animals	a_{ch}
	Fraction of ibex among wild animals	a_i
	Energy content: red deer (kcal/kg)	e_r
	Energy content: roe deer (kcal/kg)	e_{ro}
	Energy content: wild boar (kcal/kg)	e_b
	Energy content: chamois (kcal/kg)	e_{ch}
	Energy content: ibex (kcal/kg)	e_i
Labour productivity & Calorie intake	People per family	N_f
	Fraction of family who work in the field	W
	Area ploughed with ard (m^2/pn-hr)	s_t
	Cereal area reaped/threshed (m^2/pn-hr)	s_r
	Grass area cut (m^2/pn-hr)	s_c
	Potato area harvested (m^2/pn-hr)	s_p
	Length of working day (hr/day)	τ
	Length of working year (day/yr)	σ_{yr}
	Fraction of family requiring reduced calories (young/old)	δ_{yo}
	Daily energy requirement per person (kcal/pn/day)	C
	Daily energy requirement p.p. young/old (kcal/pn/day)	C_{yo}

CATEGORY	PARAMETER	NAME
Agriculture parameters	Seeding fraction of the yield	γ
	Yield fraction lost to pest etc.	λ
	Energy content of crops (kcal/kg)	e_g
	Energy content of potato (kcal/kg)	e_p
	Fruit/vegetables fraction of land	δ_f
	Settlement area (ha)	A_0
	Population density (pn/ha)	ρ
	Unmanured cereal yield (kg/ha/yr)	Y_u
	Unmanured potato yield (kg/ha/yr)	Y_{pu}
	Ratio of manured to unmanured yield (kg/ha/yr)	r_{mu}
	Manure produced by cattle (kg/hd/yr)	m
	Manure applied to fields (kg/ha/yr)	μ
Wool and cheese parameters	Fraction of wool used for local consumption	f_{wc}
	Wool production (kg/hd/yr)	y_w
	Cost of wool (Kr/lb)	R_w
	Cost of labour (Kr/day)	R_l
	Cost of cheese (Kr/lb)	R_{ch}
	Fraction of dairy used for local consumption	f_{dc}
	Conversion from Habsburg pound to kilogram	σ_{lb}
	Kg of hard cheese produced for 1 l of milk	δ_{ch}
Trashumance parameters	Fraction of year that mid-altitude area is used	δ_{mid}
	Fraction of year that high-altitude area is used	δ_{high}

SUPPLEMENTARY 2: Simulation Outputs

CATEGORY	PARAMETER	NAME	M1	M2
Field areas	Cereal area (ha)	A_{cereal}	18.5	22.2
	Potato area (ha)	A_{potato}	—	11.1
	Fruit and vegetable area (ha)	$A_{fruit,veg}$	9.3	11.1
	Lowland grazing area (ha)	$A_{graze,low}$	—	—
	Mid-altitude grazing area (ha)	$A_{graze,mid}$	113.3	162.3
	High-altitude grazing area (ha)	$A_{graze,high}$	113.3	162.3
	Lowland meadow area (ha)	$A_{meadow,low}$	61.2	97.9
	Mid-altitude meadow area (ha)	$A_{meadow,mid}$	113.3	162.3
Arable yields	Cereal yield (kg/ha/yr)	Y	1265.2	1264.2
	Potato yield (kg/ha/yr)	Y_{pot}	—	10535.
	Fraction of fields manured	f_m	0.27	0.27
Domestic animal populations	Cattle (hd)	N_c	91	143
	Sheep/goats (hd)	N_s	227	196
	Pigs (hd)	N_{pi}	45	18
	Horses (hd)	N_h	—	—

CATEGORY	PARAMETER	NAME	M1	M2
Wild animal populations	Red deer (hd)	N_r	21	25
	Roe deer (hd)	N_{ro}	21	25
	Wild boar (hd)	N_b	11	13
	Chamois (hd)	N_{ch}	21	25
	Ibex (hd)	N_i	11	13
Labour costs	Cereal reaping time (day/yr)	T_{reap}	8.2	4.9
	Grass cutting time (day/yr)	T_{cut}	26.2	19.9
	Potato harvesting time (day/yr)	T_{pot}	—	4.6
	Sheep shearing time (day/season)	τ_{shear}	0.9	0.8
	Milking time (hr/day)	τ_{milk}	5.7	4.5
Wool economy	Wool production (kg/yr)	Y_{wool}	453	98.
	Wool income (Kr/yr)	I_{wool}	16200	4200
	Income labour equivalent (pn-day/yr)	$I_{wool,day}$	1080	131
	Income labour equivalent (FTE)	$I_{wool,FTE}$	4.3	0.5
Dairy economy	Cheese production (kg/yr)	Y_{cheese}	1550	20300
	Cheese income (Kr/yr)	I_{cheese}	8320	326000
	Income labour equivalent (pn-day/yr)	$I_{cheese,day}$	554	10200
	Income labour equivalent (FTE)	$I_{cheese,FTE}$	2.2	40.7