The 83rd Annual Conference of the Agricultural Economics Society

Dublin

30th March to 1st April 2009

The impact of changing agricultural policies on jointly used rough pastures in the Bavarian Pre-Alps – an economic and ecological scenario approach –

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Abstract

The following paper assesses the impact of different policy options on the land use and associated biodiversity values of jointly organized low intensity grazing systems ('Allmende') in Southern Bavaria. We use an integrated economic and ecological modelling approach to compare the results of the scenarios with a reference situation that reflects the Common Agricultural Policy prior to the Fischler Reform. The economic sub model is based on single farms which alter their land use in response to economic stimuli. Within the economic part, key factors like the farm's endowment with machinery, quota and buildings but also the farmer's attitude are regarded. Within the rule based ecological sub model we analyze three main parameters: (a) protected habitats according to the EC Habitats Directive, (b) biodiversity for selected taxonomic groups (plants, lichens, ground beetles) and (c) habitat quality of selected target species (plants, butterflies). An overall evaluation of the scenarios leads to the conclusion that the impact of the Fischler reform will be fairly limited in the study area, since at the observed level of intensity the lower product prices will be compensated by higher direct payments. If all payments were strictly targeted to agri-environmental measures and set to a level which guarantees a low input management of the grass land, the overall public expenses could be reduced by approx. 100 to 200 € ha^{-1}. In addition this setting will provide additional habitats for the target species. However, the number of agricultural employment opportunities and the agricultural value added decline severely. Regarding all indicators but the extent of protected habitats and the public costs, a scenario of complete market liberalization performs the worst.

Keywords: CAP; agent based modelling; BioAssess; impact assessment; biodiversity; agriculture; target species; EC Habitats Directive

JEL Code: Q18, Q57

1. Introduction

The semi open mires of Southern Bavaria are of high conservation value (see Lederbogen *et al*., 2004). Some of them are still traditionally used and maintained by extensive jointly organized low intensity grazing systems ("Allmende"). In addition the amenity of these "Allmende") is not insignificant for the landscape. Through the maintenance of these pastures, the attractiveness of the region for recreation and tourism activities is enhanced.

During the vegetation period heifers graze the "Allmende". Although the utilisation of these pastures is supported by a wide variety of financial support measures (agri-environmental and less favoured area payment), the exploitation of the "Allmende" is threatened in principle. First of all the low productivity and the remoteness of the land often induce high costs per unit of output. Second, only a small fraction of the farms realize the full time-saving benefit of not having any heifers in the comparatively labour-intensive cow stables (small sized stables, solid dung removal) during the vegetation period. Third, the increasing milk productivity of approximately 100 kg per cow and year implies that the number of animals per farm needed to fulfil the milk quota is constantly decreasing (BayStMELF, 2002). As a consequence the less favoured areas such as the cooperative pastures in the mountains might be laid fallow in future.

The continuation of the utilisation of the cooperative system, and therefore, the maintenance of high nature value grassland, depends crucially on the competitiveness of the involved agricultural enterprises. This factor cannot be assessed without taking into account national and EU policies and promotion schemes as well as the likely development of the Common Agricultural Policy (CAP). As a consequence of the Fischler Reform 2003 (Council regulation 1782/2003) many surveys and agri-economic models expect a decline in cattle farming in the EU (e.g. Tranter et al. 2007 and overview in Gohin 2006).

In the recent years several studies, using agri-economic models, analyzed the impact of a changing business environment on environmental indicators. The integration of indicators for the influence of agriculture on diffuse emissions (e. g. erosion, global warming potential, NO_3 leaching,…) is state of the art even for regional agri-economic models (e. g. Schmid & Sinabell 2007; Mittenzwei et al. 2007, Pacini 2004). The impact of a changing business environment on the biodiversity of agricultural (semi natural) habitats is either analyzed using single farm models (e. g. Meyer-Aurich et al. 2003, Oñate et al. 2007) or is restricted to the evaluation of land cover changes (e. g. arable land to grassland or fallow) (e. g.Gottschalk et al. 2007, Brady et al. 2007).

However, changes in the grassland in response to economic drivers or often gradual (e. g reduced stocking rather than abandonment of areas). Furthermore the low availability of land is one of the main factors limiting the expansion of dairy farms in Southern Bavaria. Therefore, we develop an agent based modelling approach to cover the interdependencies of the farm development and delimit the impact of different policy options. This model was linked to rule based ecological model which assess the consequences for biodiversity values for typical co-operative management unit (MU) in Southern Bavaria. The considered policy options are decoupling of 1st pillar payments, abolishment of all public subsidies and the restriction of public payments to agri-environmental payments. The model is based on single farms which can gradually alter their land use in response to economic stimuli and interact on the land market.

Important questions in the context of changing or maintaining agricultural policies are: Which could be the consequences for biodiversity, nature conservation value, employment opportunities and agricultural value in this region? Which possible scenarios show the best performance regarding economic as well as ecological targets?

2. Study area

The study area is located between the cities of Füssen and Weilheim close to the city of Steingaden in the southern part of Upper Bavaria. The study area is part of the Pre-alpine moraine belt and lies at an altitude of roughly 800 m. a. s. l. It is characterized by a mean annual temperature of 6°C, high amounts of snow during winter time and an annual precipitation between 1’200 and 1’500 mm a^{-1}. These conditions together with deep soils allow an intensive management of the grassland on nearly 90 % of the region’s agricultural area (Roeder *et al.*, 2005). The average farm in the area uses 25 ha of grassland and derives its agricultural revenues chiefly from dairy farming supplemented by some revenues from heifer breeding and beef production. Most farms keep their dairy cows indoors year-round while the heifers, young cattle and horses graze rough pastures from May to October (Lederbogen *et al.*, 2004).

These rough pastures are located at sites which cannot be exploited intensively, due to e. g. their remoteness, altitude, or slope. A significant part of these pastures is still managed jointly by several farmers (“Allmende”). In Southern Bavaria, mainly in the Alps, roughly 60’000 ha of agricultural land, chiefly rough pastures, are managed by approximately 160 “Allmende” (Gueydon *et al.*, 2007). An “Allmende”’s average size is 250 ha in the alpine region and 52 ha in the pre-alpine. Typically an “Allmende” supplies less than 10 % of a farm’s annual forage demand (Roeder *et al.*, 2005). However, in the alpine region the respective share may reach up to 50 %.

2.1 Economic characterization of the study area

For the study we interviewed 25 randomly selected farms twice, a first time in 2000/01 in the course of the "Allmende"-project and again in winter 2004/05. These farms manage in total 607 ha of privately owned agricultural land. Furthermore the studied farms use roughly 150 ha of "Allmende" with equivalent of 210 heifers grazing 150 days per year.

23 of the 25 farms in the study area are dairy farms (Tab. 1). Only two farms keep suckler cows. These two farms must be conceived as part-time or even spare time enterprises. Most dairy farms are operated fulltime. The smallest farm in the sample manages 5 ha of grassland while the largest farm uses 50 ha.

Tab. 1. Economic characteristics of the considered farms (n = 25)

Farm type	lots	n° of farms	Grassland (ha)			Share of rented land (%)			Labour demand (Wh)		
			Min	Avg.	Max	Min	Avg.	Max	Min	Avg.	Max
dairy cow											
	15	7	12	17	22	5	20	36	2 400	2 800	3 000
	25	9	16	23	28	9	27	58	3 150	3 600	4 000
	40	7	25	37	50	4	40	64	4 250	4 700	5 200
suckler cow											
	5	1		6			50			800	
	15	1		29			14			1 500	

Source: Own data

In general, the larger the farms are the higher is the percentage of rented land and the higher is the milk production per hectare and consequently the management intensity (Tab. 2). But the bandwidth within one group is in most cases larger than differences between the groups.

Tab. 2. Intensity of milk production of the implemented farms (n = 25)

Farm type	lots	milk quota per farm (kg)			milk quota per ha (kg)		
		Min	Avg.	Max	Min	Avg.	Max
	15	50 000	75 000	90 000	2 700	4 700	6 900
dairy cow	25	100 000	139 000	200 000	4 000	6 200	8 700
	40	150 000	227 000	300 000	4 400	6 300	8 100

Source: Own data

2.2 Ecological characterization of the management unit

The previously described study area embeds the "Management unit" (MU). Due to limited resources we could only conduct a detailed data collection and ecological assessment for the MU. The MU has a size of 247 ha, including forests, roads, privately managed grassland and one "Allmende" of 32 ha. The MU is managed by three of the studied farms. The MU is ecologically characterized by a habitat mosaic of forests, more or less improved pastures and meadows on mineral soils, calcareous fens, transition bogs and peat bogs (see Tab. 3 and

Tab. 4). The privately managed land is mainly located on dry to fresh to mineral soils and covered by agriculturally improved and fertilized grassland or mixed woodland. The "Allmende" is dominated by permanent mesotrophic pastures, mixed *Abies-Picea-Fagus* and broadleaved swamp woodland. We collected the ecological data during the "Allmende"-project (see Lederbogen *et al.*, 2004) and in 2003/04 in additional surveys on target species, habitat types and selected taxonomic groups. According to Tab. 3 we divide the MU into five different strata, each characterized by a specific combination of utilization and vegetation. In each stratum we randomly select five subplots to sample plants, lichens and carabids according to the BioAssess protocols (Bergamini *et al.*, 2005; Scheidegger *et al.*, 2004). We selected plants to depict plant herbivore interactions and α-diversity, carabids to characterize the trophic level and lichens to indicate the disturbance respectively landscape history. In each subplot covering 1 ha species were recorded at one (carabids), seven (plants) and twelve (lichens) randomly chosen collecting sites. For the projection of the total species richness per stratum we use the data at subplot scale and the non-parametric estimator Chao 2 (Colwell & Coddington, 1994).

Tab. 3. Definition, extent and species richness of the different forms of land use (strata) in the management unit[1]) (Status Quo)

Stratum label	Short stratum definition	Long stratum definition	Area (ha)	Plants (n°)	Lichens (n°)	Carabids (n°)
1	Forest, not grazed	Secondary and natural forest without grazing	49.5	105	14	25
2	Abandoned land	Early successional stages (5 to 10 years old) without shrubs and trees. Fallows or grasslands which are managed every second or third year only are not considered abandoned	1.7	171	8	16
3	Mown grassland	Improved grassland cut at least twice a year	138.7	246	23	25
4	Low input pastures and meadows	Unimproved grassland grazed at low stocking densities or mown once a year, including open pastures, semi-open, pasture woodlands, or litter meadows	35.6	166	2	31
5	High input pastures	Improved grassland used as mainly rotational pastures; maybe cut in spring or at the end of the vegetation period	13.7	54	0	27
others	Infrastructure etc.	Streets, buildings and other facilities	8.4			
Total			***247.6***	***368***	***34***	***56***

Source: Own data

In total we collected 368 plant, 34 lichen and 56 carabid species (Tab. 3). Mown grassland (stratum 3) covers over 56 % of the MU. However, they contain only very few plant and not a single lichen species but fairly high number of different carabid spices (27). Compared to the high input pastures (stratum 3) the plant species diversity of the mown grassland is significantly lower, 166 and 54 species respectively. The low input pastures (stratum 4) are characterized by a high species diversity in all investigated taxonomic groups. In relation to their extent, the 2 ha of abandoned land (stratum 2) contain a considerable plant species diversity. This high diversity can be explained by the pronounced heterogeneity with respect to the site conditions of the different abandoned plots.

We mapped the selected target species and habitat types for the entire MU. Habitat types were classified according to the EUNIS-system (European Nature Information System habitat classification and to Annex I of the EC Habitats Directive. About 11.5 % (28.5 ha) of the area of the MU is covered by habitat types of Annex I EC Habitats Directive ("EC habitat types") (Tab. 4). The dominating "EC habitat type" is the alluvial forest with *Alnus glutinosa* and *Fraxinus excelsior* (17.3 ha). Priority "EC habitat types" in the MU are the above mentioned alluvial forest, species-rich *Nardus* grassland (1.2 ha) and active raised bogs (0.7 ha).

Tab. 4. Overview of habitat-types according to Annex I (EC Habitats Directive) and their respective current extent in the management unit[1](Status Quo)

Habitat-Type	Size (ha)
* 7110 (Active raised bogs)	0.66
7230 (Alkaline fens)	0.32
* 91E0 (Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*)	17.33
6430 (Hydrophilous tall herb fringe communities of plains and of the mountain to alpine levels)	0.34
6410 (Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	5.61
* 6230 (Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas)	1.16
7140 (Transition mires and quaking bogs)	3.05
Total	28.47

Source: Own data
* indicate priority habitat-types
1) Spatial reference: area of the 3 farms belonging to the MU

For the area the ecology of 14 plant and three butterfly species that are linked to open or semi open habitat types and are of some relevance species for nature conservation (red list species) was studied extensively in the "Allmende"-project (Lederbogen *et al.*, 2004). For these 17 species we assess the likely changes in the extent of suitable habitats induced by management changes. Currently, only the rich fens (EUNIS type D.4.1) and the transition mires and quaking bogs (D.2.3) provide suitable or very suitable habitats for a larger number of target species (Tab. 5). These two types cover over approximately 1.4 % (3.4 ha) of the MU. Only six further types show at least high qualities for more than one target species.

Tab. 5. Habitat suitability on EUNIS-3-level for 17 selected target species[1)]

Target species	EUNIS-type												
		D1.1	D4.1	D2.3	E3.5	E3.4	D5.3	D5.2	E2.1	E1.7/P-35.12	G1.4/G1.1	E2.1/E1.7/P-35.12, E1.7/P-35.12/E2.1	E2.6, G1.6, G4.6, E5.6FA.3, G5.2, E2.1, E5.4,
Plants													
Apium repens					3	3		3					
Carex canescens		3	2	2									
Cirsium rivulare					3	2							
Epipactis palustris		2	3		1	1	2						
Eriophorum latifolium	1	3	3		1	1	1						
Gentiana verna		3	1		1	1		1	3			3	
Menyanthes trifoliata	2	2	3		1	1	2			1			
Parnassia palustris	1	3	3		1	1	2			1			
Pinguicula vulgaris		3	3		1	1	1		1			1	
Polygonum bistorta					3	1							
Primula farinosa		3	3		1	1	1						
Splachnum ampullaceum	1	2	3		1	1							
Succisa pratensis		3	1	2	1					1			
Sweertia perennis		1	3				1			1			
Butterflies													
Boloria aquilonaris	3	1	2										
Coenonympha tullia		2	3	1			1		1				
Glaucopsyche alcon		2	3	2			1		2				
number of assessments with rank 1	**3**	**2**	**2**	**1**	**9**	**9**	**6**	**1**	**2**	**4**		**1**	**0**
number of assessments with a rank exceeding 1	**2**	**12**	**12**	**3**	**3**	**2**	**3**	**1**	**2**	**0**		**1**	**0**

Source: own data

(Legend for the table except for the last two lines: 'blank' = not suitable, 1 = moderately suitable, 2 = suitable, 3 = very suitable)

1) 14 plant species, 3 butterfly species

3. Modelling approach

Fig. 1 provides an overview of the general information flow within the model and explains the overall concept. The general modelling approach is the following: An agent based model is run at the level of the study area as the agri-economic sub-model. In this sub-models a set of agents adapt their land use in response to changes in their business environment (scenarios). The agri-economic model delivers area type specific information on the applied management regime and intensity. Only the information for the land use within the MU was fed into the ecological sub-model. Based on the information from the economic model and additional information like the location of the managing farm, the distribution of vegetation types and target species, the species richness per stratum, the vegetation trajectories or topography and we determine the ecological impact of the respective scenarios. The ecological assessment of the agri-economic scenarios is based on their expected impact on the extent of "EC habitat types”, the species richness and composition as analysed from plants, lichens and carabids and the extend of suitable habitats for a set of target species.

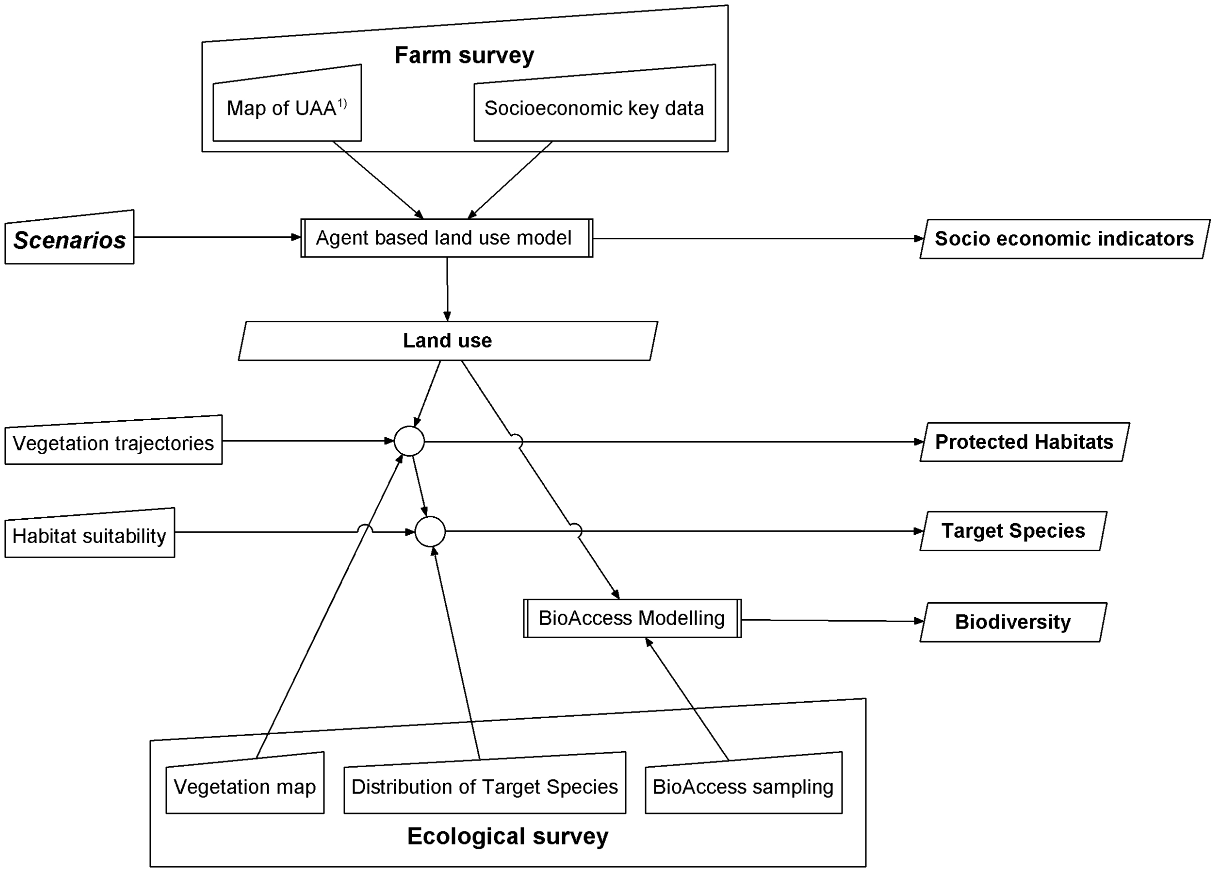

Fig. 1: Information flow within the model
Source: own data
1) UAA: utilized agricultural area

3.1 Agent based agri-economic sub model

For the study we choose an integrated comparative static farm sample model for the economic modelling (c. f. Hanf & Noell, 1989). In the model each farm is represented by one farm agent. In addition to the integration of the direct effects of changing business environments on farm organisation, an integrated farm sample model allows to incorporate the indirect effects like the change of land prices in response to modifications of the CAP.

The agents have various options in order to achieve an optimal result under a given business environment. They can modify their farm type by investing in buildings and machinery, or disinvesting, lease and rent quota or land, change the applied production techniques and adapt the management intensity. Not all factors of the business environment are static and pre-defined in each model run. The 25 farm agents compete for the agricultural land in the study area and the resulting land rent reflects the endogenous market price for a given scenario. The land market is included in the model since in the considered region the potential growth of family farms is mainly limited by the availability of land.

Each farm agent is assigned a farm-type based on the underlying farms endowment with buildings and machinery. The amount and physical properties of the agricultural land which is managed by each farm agent corresponds in quality, ownership status and site structure (distance from the farmstead and size) to the ones of the respective farm. For an appropriate differentiation of the agricultural land we divided the agricultural land into seven different categories based on the plot's physical properties. Six of these categories concern privately managed land. Most of the privately managed area is high productive grassland. These stands can be either grazed or cut. The majority of this type of grassland is currently used four to five times a year. A slightly less intensive use is possible. Due to legal restrictions or characteristics of the site the less productive stands can either only be grazed or cut at low intensities. The privately managed grasslands are explicitly modelled, meaning that specific sets of production techniques can be assigned to each category, e. g. farm A mows 20 % of the small low productive plots which are located at a significant distance from the farmstead only once a year or farm B installs a rotational pasture on 2 ha on the plots in the vicinity of its farmstead to feed its dairy cows.

In contrast, the use of the "Allmende" is only indirectly depicted via the entitlements to graze heifers or suckler cows on them. The reason for this simplified procedure is that the differences in the costs and benefits of the different forms of low input grazing, which is the only technically and legally feasible option for the "Allmende", are negligible compared to the ones related to differences in housing system and productive orientation. Each farm agent has an endowment with grazing right which is equivalent to its current utilization of the rough pastures. Animals grazing on the pastures have a lower working demand and have a lower demand on forage produced on the privately managed pastures since they cover some of their forage demand on the rough pastures. In order to depict the situation prior to the decoupling, each farm agent receives an endowment with suckler cow quota and milk quota, which is equivalent to the farm it represents.

Especially in dairy farming systems differences in the "farming style" of the farmers must be considered to adequately the farmers' response to policy changes (Gibon, 2005; van der Ploeg, 2004). In order to depict these differences in "farming style" we use an approach developed by Roeder (2007). This approach is based on the idea that differences in the observed "farming styles" are a result of the differences among the farmers in their valuation of imputed costs (e. g. capital and labour) and their overall willingness to support agriculture from other income sources respectively their requested entrepreneurial profit. To depict these differences a set of farm specific control variables is calibrated in a way that each farm agent organizes his farm like its real world counterpart. Farm agents leave agriculture if they cannot meet their respective goals defined by the control variables. For the modelling we assume that the farm agent can only choose between discrete, explicit farm types; the production of the farms has no impact on the prices of the products (small country assumption); and that no technical progress takes place (esp. milk yield per cow). For further details on the implementation of the land market, the calibration process, the used technological coefficients and modelling approach see Roeder *et al.* (2006) and Roeder (2007).

3.2 Rule based ecological model

For the study we delimit several land use types, which differ with respect to the initial land use, the initial vegetation cover, the topography, the ownership, the plot size and other geographic information. In each scenario the spatial allocation of the resulting land use is deduced using the distribution and allocation given by the economic model as well as expert knowledge which is based on plausible assumptions on the behaviour of farmers (e. g. grazing of dairy cattle only in the vicinity of the farmsteads, less intensive use of the smallest and most distant plots, preference for mowing on smaller and more remote plots, etc.). Knowing the current vegetation types and species composition as well as the most likely land use (meadow, pasture, mowing pasture, fallow) and the utilisation intensity, we determine the probable changes on the level of EUNIS habitat types using the successional trajectories published in Lederbogen *et al*. (2004).

Since the concept of strata generally reflects directly the differences of the underlying land use the conversion of the geometries resulting from the economic sub model into ones with ecological meaning is in most cases straightforward. Using the original area of each stratum and considering the relative change among these strata expressed by transition matrices corresponding to each scenario, the BioAssess results are used to evaluate the relative impacts of a given scenario on species richness for the selected taxonomic groups. Based on the methodology and on the results published in Lederbogen *et al*. (2004), we assess the suitability of the different vegetation and habitat structure types in the study area as habitats for the target species. This information is aggregated at the level 3 of the EUNIS classification. When a EUNIS-type includes several vegetation or structure types an intermediate value is assigned.

The evaluation of the overall habitat suitability (I_s) in a given scenario is based on the median of the suitability scores for the individual species (formula 1). The suitability scores of the individual species ($k_{i,s}$) are derived from the weighted sum of the area of the suitable habitats in given scenario. To account for differences in the responsiveness to management changes of the species scores are range standardized.

(1)
$$I_s = Median\{\bar{k}_{1,s},\ldots,\bar{k}_{i,s}\};$$
$$with\ \bar{k}_{i,s} = \frac{\left(k_{i,s} - Minimum\{k_{i,1},\ldots,k_{i,s}\}\right)}{Range\{k_{i,1},\ldots,k_{i,s}\}};$$
$$with\ k_{i,s} = \sum_{j=0}^{3} a_{i,s,j} * v_j;$$

i = target species;
s = scenario (including the reference);
j = habitat suitability class (0 = unsuitable, 1 = moderately suitable, 2 = suitable, 3 = very suitable);
$a_{i,s,j}$ = area covered by habitats of given suitability class *j* for species *i* in scenario *s*;
v_j = valuation factor of the respective habitat suitability class *j*.

3.3 Scenario development and modelling including model specification

In order to assess the impact of the implementation of the Fischler Reform we calculate a reference (REF) and three scenarios. REF is not a “true” scenario as its ecological evaluation is primarily based on the collected field data and not like the economic evaluation on the projections. REF depicts the situation prior to its implementation with coupled payments of the 1st CAP pillar and a comparatively high milk price (Tab. 6). The first scenario (DECOUP) reflects a situation after the full implementation of the German model. In Germany the premiums are fully decoupled and after 2013 a regional flat rate premium will be paid (BMELV, 2007). We base our calculations on a target value of 280 € ha^{-1} which is lower than the currently expected target value of 350 € ha^{-1} for Bavaria (BMELV, 2007), since we include discounts for modulation and financial discipline. In the second scenario (LIBERAL) agricultural commodity markets are liberalized and all public payments for agriculture including agri-environmental ones are abandoned. While in the third one (AEP) agri-environmental payments were maintained and set to a level which insures an area wide low input management of the land. For the three scenarios we assume that the milk price will drop to 27 ct kg^{-1} and that mulching can only claim the area payment but no other public payment.

Tab. 6. Overview of the assumed prices and transfer payments in the scenarios

	REF	Scenario DECOUP	LIBERAL	AEP
Prices				
Milk price[1] (ct kg^{-1})	35	27	27	27
Quota price[2] (ct kg^{-1})	60	30	0	0
Beef prices	Avg. prices from 2000 to 2004	Prices from fall 2005	Prices from fall 2005	Prices from fall 2005
Direct payments				
Area payment (€ ha^{-1})	0	280	0	0
Animal premium (€)	Depending on the type of animal	0	0	0
Compensatory payment (€ ha^{-1})	145	145	0	0
Agri environmental payment (€ ha^{-1})	200	100	0	500

Source: Own data
1) average milk prices in Bavaria incl. VAT
2) in Upper Bavaria

The assumptions and coefficients in the economic model reflect a time horizon of 5 to 10 years, since for this period political and technical developments can be assessed with some confidence and some adaptations with regard to fixed assets are likely to occur on the farm level. However, in this period land use changes will hardly have any ecological impact on the MU. Therefore, we base our ecological assessment on the assumption that the projected changes in the management will last for at least 30 years.

4. Results

The results are presented as follows. First we show the economic results of the scenario calculations using the profitability, the labour input and the farm structure as main indicators. This is followed by a closer look on livestock husbandry and forage cropping. Then we present the impact of the changes in land use on the strata and vegetation types. Finally, we depict the consequences for “EC-habitat types”, biodiversity and target species.

4.1 Economic results for the scenarios and resulting land use characteristics

In the following sections the results are presented, where appropriate, in a twofold manner. One set of results depicts the wider study area that consists of 25 farms. The other set depicts focuses on the farms managing the MU.

First, we will have a brief look at some general economic indicators for the whole study area. DECOUP leads to a roughly 20 % lower labour intensity and short term profitability (gross margin per ha) of farming compared to REF, while the tenure nearly doubles (Tab. 7). This rise can be explained by the lower labour demand per ha - and therefore declining labour costs and the competitiveness of mulching. LIB leads to a collapse of the farm structure and the land market. In AEP the general economic indicators (gross margin, labour demand and tenure per ha) have significantly lower values compared to REF.

Tab. 7. Producitivity and tenure in the scenarios (study area)[1)]

	Scenario			
	REF	DECOUP	LIBERAL	AEP
Working hour (Wh ha^{-1})	131	111	5	25
Gross margin (€ ha^{-1})	1 590	1 240	30	415
Gross margin (€ Wh^{-1})	12	11	7	16
Tenure (€ ha^{-1})	82	147	0	13

Source: Own data
1) 25 farms

The REF reflects the current situation fairly well with only one farm being abandoned (Tab. 8). The farming structure is dominated by medium to small sized dairy farms. The implementation of the Agenda 2003 (DECOUP) has only a minor impact on the farming structure. Only six farms modify their structure significantly. Four farms will cease farming and two will conduct mulching as their only activity. In the study area decoupling will affect larger farms more negatively than the smaller ones. This is due to two reasons. In tendency the larger farms have a higher share of rented land for which higher tenure must be paid. In addition their milk yield per ha is higher and consequently the benefits of the additional regional payment do not compensate the loss due to the declining milk price. All farms in the MU continue their business without any modifications. Under liberalized conditions (LIB) only one small farm survives. In AEP four farms operate in the study area. Two of them expand their acreage and change from dairy to suckler cow farming. One of these expanding farms is located in the MU.

Tab. 8. Farm specialisation and size in the study area (n=25) (n° of farms in the respective group).

		(n° of farms) Scenario			
Farm type	lots (n° of animals)	REF	DECOUP	LIBERAL	AEP
dairy farm					
	15	6	7	1	1
	25	8.5	5		1
	40	7 (3)[2]	6 (3)		
medium dairy / suckler cow farm	15 / 15[1]	1	1		
suckler cow farm					
	5	0.5			
	15	1			
	120				2 (1)

maintenance[3]	-		2		
abandoned	-	1	4	24 (3)	21

Source: Own data
1) 15 lots for suckler cows and 15 lots for dairy cattle
2) in brackets number of farms in the MU belonging to this group
3) farms conducting mulching as their only activity

Tab. 9 shows that the regional stock in REF is dominated by dairy cattle which are fed by fodder from high input meadows and pastures (88 % of the study area's grassland). Under DECOUP the livestock numbers are lower reflecting the smaller number of farms. The number of animals drops because the remaining farms do not expand their business as additional investments are not adequately reimbursed but the utilisation of existing capacities remains profitable. The extent of low input beef production declines, since mulching is a very competitive activity inducing comparatively high land rents, which adversely effect in particular the profitability of low input forms of animal husbandry. The reduced animal numbers are accompanied by a lower share of high input grassland covering 66 % of the study area while 23 % of the grassland is mulched. Under LIB hardly any animals are kept and over 95 % of the grassland is abandoned. Under AEP the regional stock reaches 40% of the initial level and is dominated by suckler cows. High input pastures and meadows cover 50 % of the study area. The remainder is cut at most twice a year or is extensively grazed. As the farms operating on the MU are more competitive than the study area's average the shift towards low input farming is in the MU under AEP and DECOUP less pronounced than for the study area as a whole.

Tab. 9. Animal numbers in the study area under the scenarios (in LU)[1)]

Type of animal	Scenario			
	REF	DECOUP	LIBERAL	AEP
Animals using private land				
dairy cattle[2)]	690 (156)[3)]	587 (156)	20 (0)	45 (0)
suckler cows[2)]	22 (0)	/	/	284 (149)
fattening heifers & oxen	47 (1)	27 (1)	/	5 (0)
Animals using the "Allmende"	72 (13)	59 (13)	1 (0)	12 (0)
Total	831 (171)	672 (171)	21 (0)	346 (149)

Source: Own data
1) 25 farms
2) including the heifers for the replacement
3) in brackets LU of the animals in the MU

4.2 Changes in strata and vegetation types (EUNIS)

Under DECOUP the increasing area payments for open pasture induce an incentive to use as much land as possible (Tab. 10). Therefore roughly half of the land abandoned in REF (stratum 2) will be used and becomes low input pastures (stratum 4). Under LIB the agricultural use of the MU will cease. Therefore, the strata depending on a management (3, 4 and 5) disappear totally in favour of forests (stratum 1) and abandoned land without shrubs and trees (stratum 2). Under AEP the most marked change is that about half of the area of the meadows which were intensively used in REF (stratum 3) will turned into intensively managed pastures (stratum 5).

Tab. 10. Extent of the strata in the scenarios [1),2)]

Stratum label	Short stratum definition	Area (ha)			
		REF	DECOUP	LIB	AEP
1	Forest, not grazed	49.5	49.5	72.6	49.5
2	Abandoned land	1.7	0.8	166.5	1.7
3	Mown grassland	138.7	133.9	0.0	76.2
4	Low input pastures and meadows	35.6	36.0	0.0	36.1
5	High input pastures	13.7	19.0	0.0	74.7

Source: Own data
1) spatial reference: area of the 3 farms belonging to the MU
2) Strata as defined in Tab. 3

The changes on the level of EUNIS habitat types reflect largely the ones on the strata level. Under DECOUP wood harvesting will lead to the transition of mixed *Abies - Picea - Fagus* woodland into permanent mesotrophic pastures and aftermath-grazed meadows. Under LIB the expected changes are more drastic since all open or semi-open habitat-types are diminishing or disappearing. The intensive grassland types (E2.1, E2.1/E1.7/P-35.12, E2.6) disappear and develop into anthropogenic forb-rich habitats (E5.6). In addition habitat types which are characteristic for management boundaries (E5.4, FA.3, G5.2) or depend on extensive management (D5.2, D5.3, E3.4) perish. Scenario AEP mainly affects the grassland habitat types. In this scenario almost half of the improved grassland, (E2.6) are converted into pastures (E2.1) while half of the wet eutrophic grassland (E3.4) develops into swamps (D5.2) and parts wet oligotrophic grassland (E3.5) become rich fens (D4.1).

4.3 Ecological consequences of the scenarios

Within the time frame of 30 years the extent of some “EC Habitat types” as raised bogs (type 7110), transition mires and quaking bogs (type 7140) and species-rich *Nardus* grasslands (type 6230) will not change, irrespective of the chosen scenario (see Tab. 11). Under AEP over 4 ha of *Molinia*-meadows (type 6410) will be included into greater paddocks and become grazed alkaline fens (type 7230). A similar change in management and therefore extent of “EC habitat type” occurs at a much smaller extent under DECOUP. The flat rate area payments in DECOUP induce a thinning and clearing of 0.47 ha of wet forests. In addition some small herb fringes are included in the paddocks. The abandonment under LIB leads to an expansion of alluvial forests (91E0). In summary, DECOUP shows a small loss in the total area of "EC Habitat types", while in LIB this area will increase significantly due to strong increase of alluvial forests. Under AEP the extent of "EC Habitat types" corresponds to the initial situation (REF).

Tab. 11. Estimated changes in EC Habitats Directive Annex I-areas in ha[1)]

Habitat-Type	REF (in ha)	Changes in comparison to REF (in ha) DECOUP	LIB	AEP
* 7110 (Active raised bogs)	0.66	0.00	0.00	0.00
7230 (Alkaline fens)	0.32	0.67	0.00	4.08
* 91E0 (Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*)	17.33	-0.47	5.66	0.00
6430 (Hydrophilous tall herb fringe communities of plains and of the mountain to alpine levels)	0.34	-0.20	-0.34	0.00
6410 (Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)	5.61	-0.67	0.00	-4.08
* 6230 (Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas)	1.16	0.00	0.00	0.00
7140 (Transition mires and quaking bogs)	3.05	0.00	0.00	0.00
Total	28.47	-0.67	5.32	0.00

Source: Own data
* priority habitat-types
1) spatial reference: area of the 3 farms belonging to the MU

The strata's extent do not differ very much between REF and DECOUP. Therefore, we expect only moderate changes in species richness for the considered groups (Tab. 12). In LIB, management (grazing, mowing) of the MU ceases completely and only the strata abandoned land (stratum 2) and forests (stratum 1) remain. This loss of open managed habitats causes a strong decline in biodiversity for all regarded species groups which cannot be compensated by the increase in species richness of the two remaining strata. In AEP, mainly parts of the mown grasslands are converted into intensive pastures. As the extent of forest remains more or less the same in all scenarios the projected species richness of this stratum remains unaffected.

Tab. 12. Estimated number of species and exclusive species per stratum and species group and expected changes under different scenarios

Stratum / Species Group	Estimated n° of species (REF) total	exclusive	Number of species in relation to the reference (REF) DECOUP	LIBERAL	AEP

Forest					
Plants	125	9	[91% .. 100% .. 119%][1]	[95% .. 105% .. 126%]	[91% .. 100% .. 119%]
Lichens	19	5	[79% .. 100% .. 205%]	[84% .. 105% .. 221%]	[79% .. 100% .. 205%]
Carabids	29	10	[90% .. 100% .. 145%]	[97% .. 107% .. 155%]	[90% .. 100% .. 145%]
Abandoned land					
Plants	233	13	[78% .. 87% .. 103%]	[192% .. 238% .. 331%]	[88% .. 100% .. 121%]
Lichens	9	1	[78% .. 78% .. 133%]	[233% .. 267% .. 689%]	[89% .. 100% .. 167%]
Carabids	22	2	[73% .. 91% .. 159%]	[159% .. 200% .. 359%]	[82% .. 100% .. 182%]
Mown grassland					
Plants	57	6	[96% .. 100% .. 123%]	0%	[91% .. 95% .. 114%]
Lichens	0	0	n. a.	n. a.	n. a.
Carabids	38	4	[79% .. 97% .. 163%]	0%	[74% .. 89% .. 150%]
Low input pasture					
Plants	381	4	[87% .. 100% .. 122%]	0%	[87% .. 100% .. 122%]
Lichens	38	6	[74% .. 100% .. 187%]	0%	[74% .. 100% .. 187%]
Carabids	55	0	[67% .. 100% .. 185%]	0%	[67% .. 102% .. 187%]
High input pasture					
Plants	228	7	[91% .. 105% .. 130%]	0%	[110% .. 129% .. 164%]
Lichens	3	0	[67% .. 100% .. 500%]	0%	[100% .. 133% .. 700%]
Carabids	51	1	[80% .. 106% .. 176%]	0%	[98% .. 129% .. 218%]

Source: Own data

1) [lower bound .. average .. upper bound] of the 95% confidence interval

In general, the estimated share and absolute numbers of plant species restricted to one particular stratum (exclusive species) is relatively small in all stratums. With respect to lichens, we derive for the forests (stratum 1) and the extensive pastures (stratum 4) high absolute species numbers and high shares of exclusive species. This is quite a different picture as in vascular plants, where no species rich stratum harbours a substantial number of exclusive species. Looking at carabids, the forests contain the highest number of exclusive species while in the other strata, especially in the mown grassland and the intensive pastures, we found only few or no exclusive species. A low share of exclusive species implies that an increase in a stratum's extent is unlikely to lead to a higher overall species number for the entire MU as the additional species for the respective strata were already present in other strata.

The strong increase of the species numbers for all taxonomic groups in the abandoned land in LIB and in the intensive pastures in AEP must be interpreted with care. In both cases the initial area is fairly small (1 % and 18 % of the projected area) compared to the projected one and the sample data at the subplot scale are characterized by large differences (low within strata similarity) in the species composition due to a high heterogeneity with respect to soil conditions and exposition.

Tab. 13 shows the habitat suitability scores for the target species and the aggregated values for the respective scenarios (including REF). The highest score receives AEP while LIB gets the lowest. DECOUP performs slightly better than LIB. A sensitivity analysis shows that the ranking of the scenario is stable as long as the valuation factor (v_j) increases with the habitat suitability. The ranking is also not affected if species are excluded from the assessment that barely react to management changes, i.e. over all scenarios their minimum aggregate area of suitable and very suitable habitat is larger 80 % of the respective maximum value.

Tab. 13. Standardized habitat suitability scores for the target species[1)] ($\bar{k}_{i,s}$) and aggregated scores for REF and the scenarios (*Is*)

Target species	REF	DECOUP	LIBERAL	AEP
Apium repens	0.24	0.42	0.00	1.00
Carex canescens	0.00	0.16	0.00	1.00
Cirsium rivulare	0.89	1.00	0.00	0.88
Epipactis palustris	0.56	0.71	0.00	1.00
Eriophorum latifolium	0.56	0.70	0.00	1.00
Gentiana verna	0.28	0.47	0.00	1.00
Menyanthes trifoliate	0.00	0.21	0.08	1.00
Parnassia palustris	0.00	0.21	0.08	1.00
Pinguicula vulgaris	0.72	1.00	0.00	1.00
Polygonum bistorta	0.89	1.00	0.00	0.88
Primula farinose	0.56	0.70	0.00	1.00
Splachnum ampullaceum	0.56	0.70	0.00	1.00
Succisa pratensis	0.68	0.68	1.00	0.00
Sweertia perennis	0.00	0.04	1.00	0.74
Boloria aquilonaris	0.00	0.16	0.00	1.00
Coenonympha tullia	0.76	0.79	0.00	1.00
Glaucopsyche alcon	1.00	1.00	0.00	1.00
I_s	**0.56**	**0.70**	**0.00**	**1.00**
Average of $\bar{k}_{i,s}$	**0.45**	**0.59**	**0.13**	**0.91**

Source: Own data
$v_0 = 0$; $v_1 = 1$; $v_2 = 1.01$; $v_3 = 1.02$
spatial reference: area of the 3 farms belonging to the MU
1) 3 animal species, 14 plant species

In particular LIB will have a marked impact on the target species. Not a single target species will benefit but we expect that especially *Apium repens, Cirsium rivulare, Gentiana verna* and *Polygonum bistorta* will loose at least 80 % of their suitable and very suitable habitats. Compared to REF, in AEP the extent of suitable habitats for nine species is at least roughly twice as large. For most of these species the positive effect is due to the introduction of grazing on the 4.1 ha of moist or wet oligotrophic grassland (E3.5) developing into rich fens (D4.1). The only “looser” in AEP is *Polygonum bistorta* because 2 ha of moist mesotrophic grassland (E3.4) develop into swamps dominated by *Juncus spec*. (D5.3) which are less favoured by this species. For DECOUP we project a slight increase in the suitable area for 12 target species. Nine species of them are promoted because the area of grazed fens is enlarged by 0.67 ha.

Especially *Apium repens* shows a strong reaction on land use changes in the MU. In the MU this species is frequent on open sites and on fresh eutrophic soils with frequent trampling impact by cattle. The creeping marshwort (*Apium repens*) favours wet depressions in the 'Allmende' pastures. Here, the frequency and intensity of foraging and cattle hoof prints limit competitors guarantee sufficient open soil and time for spreading of this plant species.

5. Aggregated evaluation

Making an overall evaluation of the reference and the three scenarios, one sees first of all that the impact of the Fischler Reform is fairly limited with respect to all chosen indicators (Tab. 14). In comparison to REF and DECOUP AEP provides more habitats for the target species. We project that the extent of suitable habitats for at least nine of them will notably increase. In addition needed public support in order to maintain agriculture drops by 100 € to 200 € ha^{-1}. However, the number of agricultural employment opportunities and the agricultural value decline severely. Regarding all indicators but the extent of protected habitats and the public costs, LIB performs the worst. In LIB four target species face a significant reduction of their suitable habitats and the overall diversity of vascular plants, lichens and carabids declines. The positive result in scenario LIB for "EC habitat-types" can be traced back to the increase of alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*. Since other areas are more suitable for protecting alluvial forests this scenario clearly does not fulfil EU nature conservation targets. The impact of LIB could be dampened if at least for the listed habitats requiring agricultural land use an adequate payment would be granted.

Tab. 14. Overall evaluation of the Scenarios for the MU

Criteria	REF	DECOUP	LIB	AEP
Protected Habitats[1)]	2/3[2)]	3	1[3)]	2/3
Suitable habitats[4)]	2/3	2/3	4	1
Species richness[5)]	1/2	1/2	4	1/2
Public costs	3/4	3/4	1	2
Employment	1/2	1/2	4	3
Agricultural added value	1/2	1/2	4	3

Source: Own data
1) Extent of habitats listed in the EC Habitats Directive Annex I
2) 1 := highest, 2 := high, 3 = medium, 4 = lowest rank
3) Due to the strong increase of alluvial forest (see text)
4) Extent and quality of suitable habitats for the target species
5) Species richness of vascular plants, lichens and carabid beetles based on BioAssess results

6. Sensitivity analyses

In order to increase the confidence in the obtained result we conducted several additional calculations in which we tested the impact of some critical assumptions. In particular we were interested in the impact of the tradability of grazing rights on the utilization of the "Allmende", of changing beef prices and of the possibility to increase the per capita milk yield.

In the presented scenarios the utilization of the "Allmende" declines in the study area along with the decreasing number of existing farms. If the utilisation rights are tradable at a fixed price the "Allmende" is used with the initial intensity also in DECOUP and AEP. As only a small fraction of the regional stock grazes on the "Allmende" this utilization has barely any impact on the farm organization, farm profitability and the overall land use.

In the years since the implementation of the Fischler Reform one could observe pronounced fluctuations in the prices for agricultural commodities and in particular beef (see Pop & Artico 2009, LEL 2009). The beef prices used in this study depict the lower end of the recent years' price corridor. A beef prices at the medium to upper end of this corridor leads to significant shift towards heifer and oxen fattening in AEP and the minimum required premium level to guarantee a low input management drops by roughly 50 € ha^{-1}. The shift from suckler cow farming to heifer and oxen fattening systems under a system of high beef prices is due to the higher beef output per ha of the later. While on the hand higher beef prices stabilize farming and promote grazing in the area they induce on the hand a stimulus towards intensification. This can mean that the stocking density and the number of rotations will increase, implying a higher risk of trampling for smaller species. But more importantly, this intensification might be accompanied by measures like draining, fertilization and others which directly interfere with the habitats of endangered species.

Lower beef prices might on the other hand favour a land-use somewhere in between grazing and complete abandonment. The area payment assures that the encroachment of shrubs and trees will be limited. Since the farmers make their profit not by keeping animals but keeping the landscape open, they will try to realize this goal with lowest possible number of animals. This implies that the livestock will hardly use areas where predominantly plants of low forage value grow. This could promote monocultures of tall sedges which out compete smaller and more light-demanding species. Furthermore, wet places might be less trampled, which deprives for instance *Apium repens* of its establishment niche.

In a third additional calculation the agents were given the opportunity to increase the profitability by raising the per capita milk yield to levels of up to 9'000 kg a^{-1}. A strong increase in the milk production per farm is not unrealistic. A study by Bauhuber (2006, p. 149) shows that many Bavarian farms have the potential to increase their output by more than 30 % at an extra cost of only roughly 16 ct kg^{-1}. Given this additional option especially the larger farms expand and intensify their production on the fertile and well accessible plots while the less productive and more remote sites are abandoned. This change in management will impact the biodiversity via three different mechanisms (Lederbogen *et al*., 2004). First, the intensification of the more fertile areas affects target species confined to eutrophic wet places like *Apium repens*, since the intensification will be likely associated with a melioration of their habitats (e. g. drainage, fertilization and terrain leveling). Second, in areas with a low fodder value like forest pastures and mires grazing will be stopped or at least strongly reduced. After grazing, mowing or mulching ceases in the alkaline fens for a couple of decades, alluvial forests or tall sedge communities establish. This succession reduces step by step the habitat quality and the habitat area for many target species, including *Coenonympha tullia, Cirsium rivulare, Gentiana verna* and *Polygonum bistorta* (Lederbogen *et al*., 2004). Third, the exclusion of low productive areas like forests and mires from the management and the probable division of the large paddocks among the owners reduces the structural diversity. Especially borders between different vegetation units respectively structural types disappear (Lederbogen *et al*., 2004). Consequently, populations of animal species decline, which depend on a high structural diversity (e. g. Tree Pipit (*Anthus trivialis*)). As the turnover per ha in dairy farming is notably higher than in beef farming higher milk prices or the abandonment of the quota regime, implying lower costs of expanding the production, induce much stronger intensification incentives than higher beef prices.

After the implementation of the Fischler Reform mulching is sufficient to receive the area payment and became a very competitive form of land use for marginal grassland. In comparison to pastoral systems it is characterized by low variable costs a limited labour demand and does hardly demand any expensive equipment. Using a full cost approach mulching is frequently economically superior to pastoral activities, even if only the later are supported by agri-environmental payments. If the funds available for agri-environmental measures become more restricted (CEU, 2005) mulching might further gain in importance. Taking the specific conditions of the study site, it is quite unlikely that an increasing extent of mulched plots will negatively impact biodiversity. The reasons are that the privately used meadows are already very species poor and most of the more extensively ones cannot be mulched since the terrain and the mixture of trees and bushes and open parts make this operation technically hardly feasible. If the intensively used meadows and pastures are to be mulched, this could even promote biodiversity, since mulching is associated with the dismissal of fertilization. This in turn can lead to a gradual depletion of nutrients from the top-soil, which after decades could allow the establishment of species favoured by lower nutrient levels, which are the more rare ones in general.

7. Discussion

The projected changes in the extent of the EUNIS and EC habitats type are in most cases very small (Tab. 10 and Tab. 11). Taking into account the inevitable uncertainties associated with the scenario approach, one could argue, whether these changes in the habitat area and consequently in the extent of suitably habitats for the different species must be conceived as negligible or at least as being within the projection uncertainty. However, the derived trends for the different species under different management regimes fit well to the results of an earlier analysis for the study area conducted by Lederbogen *et al*. (2004). This study assessed the habitat suitability of the different vegetation types at a finer scale including information the current and projected conservation status on plot level. For this study the management alternatives were not intrinsically selected by the model based on some economic rationale but a restricted set of management alternatives was provided as an input for the ecological model. Consequently the management alternatives could be much more exactly described (e. g. stocking density, type of rotation, grazing period, fertilisation, size and layout of the paddock) than feasible in a model in which agents autonomously select the management system and can make investment decisions. Especially the change in an area's conservation status is not projectable with the approach used here. Changes in the conservation status may especially be relevant for species with a broader ecological niche like *Succisa pratensis* and *Glaucopsyche alcon*.

The presented approach is capable to depict the impact of changing economic conditions on the species diversity in high nature value grassland systems. However, it is plagued with some intrinsic problems related to the assessment of the biodiversity impact of dairy systems. As shown the impact of dairy farming on biodiversity depends on the overall management intensity and the specific combination of management systems (cf. Tab. 3 for the differences in the species richness of high input pastures and mown grassland or Ellenberg (1996, p. 784 ff.)). However, for dairy farms the determination of the most likely grassland management system (e. g. grazing vs. cutting) is associated with a high degree of uncertainty. First, agricultural systems are frequently characterized by flat production functions implying that over a wide range of applied management intensities the economic output remains nearly unchanged (Pannell, 2006). This holds in particular for the intensity and type of grassland management in dairy farms if investment options are considered. In dairy farming only 25 % of the variable costs and less than 10 % of the total costs of Bavarian dairy farming are linked to cash based forage costs (e. g. Bauhuber, 2006: p. 114 ff.). The calculations for the farms in study area show in addition that less than a quarter of the farms' total labour demand is associated with grassland management while the more than half is linked to the general herd management of the dairy cows. This implies that especially the long and medium term economic success of a dairy operation is only loosely related to the chosen grassland management system. Second, the impact of the dairy farming system in the study area on biodiversity is largely determined by the chosen feeding system for the replacement heifers. However, the fattening of the replacement heifers is a subsidiary economic activity. In addition heifers have compared to the dairy cows lower requirements regarding the energy content and quality of the forage, the farmer can choose among a wide variety of different feeding strategies. These strategies operate on different points on the trade off curve between the age of first calving and the forage quality (Kirchgessner, 2004 p.400 ff.). Whether the costs induced by a higher age of first calving are compensated by the savings induced by a lower quality diet depends on the specific conditions (scarcity of lots for heifers, herd size, herd management, plot structure, agri-environmental payments, rents, availability of land, seasonal bottlenecks in labour supply …).

8. Acknowledgements

We owe gratitude to Joao Paulo Fernandez, Giselher Kaule and Helmut Hofmann for the excellent cooperation. Our colleagues Anne Gueydon, Gabriel Hermann, Kathatrina Niemeyer, Joerg Rietze and Roland Steiner helped during the field work and the analyses. Financial support was provided by the German Federal Ministry for Education and Research (BMBF) and the European Union in the framework of the Allmende research project (Large scale co-operative grazing system / "Allmendweiden" / as an alternative management concept for threatened open and semi-open landscapes, FKZ 01LN0005) and the project LACOPE (Landscape Development, Biodiversity and Co-operative Livestock Systems in Europe Contract No. EVK2-CT-2002-00150).

9. References

Bauhuber G (2006) Wirtschaftlichkeit und Standortorientierung der Milchwirtschaft unter dem Einfluss der Agrarreform, Ph. D. Thesis at the TU München Weihenstephan, mediatum2.ub.tum.de/node?id=603718, p. 192.

BayLfSD (Bayerisches Landesamt für Statistik und Datenverarbeitung) (2000) Statistisches Jahrbuch für Bayern.

BayStMELF (Bayerisches Staatsministerium für Ernährung, Landwirtschaft und Forsten) (2000) Bayerischer Agrarbericht 2000, München.

BayStMELF (Bayerisches Staatsministerium für Landwirtschaft und Forsten) (2002) Bayerischer Agrarbericht 2002, München.

Bergamini A, Scheidegger C, Stofer S, Carvalho P, Davey S, Dietrich M, Dubs F, Farkas E, Groner U, Kärkkäinen K, Keller C, Lökös L, Lommi S, Maguas C, Mitchell R, Pinho P, Rico V J, Aragon G, Truscott A-M, Wolseley P and Watt A (2005) Performance of Macrolichens and Lichen Genera as Indicators of Lichen Species Richness and Composition. Conservation Biology 19 (4): 1051-1062.

BioAssess (2004) BioAssess - Methods and Results. nbu.ac.uk/bioassess/Methods_Results.htm, lastly modified 11.08.2004.

BMELV (Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz) (2007) Aktualisierte Schätzwerte für die regional einheitlichen Zahlungsansprüche im Rahmen der Betriebsprämienregelung. bmelv.de/nn_751434/SharedDocs/downloads/04-Landwirtschaft/Foerderung/Direktzahlungen/AktualisierteSchaetzwerte,templateId=raw,property=publicationFile.pdf/AktualisierteSchaetzwerte.pdf; Bonn: April 2007.

Brady M, Kellermann K, Sahrbacher C, Jelinek L and Lobianco A (2007) Environmental Impacts of Decoupled Agricultural Support: a Regional Assessment. IDEMA deliverable. sli.lu.se/pdf/SLI_WP20071.pdf. lastly accessed: 22.12.2008.

CEU (Council of the European Union) (2005) Financial Perspective 2007-2013; ue.eu.int/ueDocs/cms_Data/docs/pressData/en/misc/87677.pdf; Brussels, 19 December 2005.

Colwell R K, Coddington J A (1994) Estimating terrestrial biodiversity through extrapolation. In: Hawksworth, D. L. (ed) Biodiversity: measurement and estimation. The Royal Society, London: 101–118.

Ellenburg H. (1996) Vegetation Mitteleuropas mit den Alpen. 5th edition.. Stuttgart. p. 1095.

Gibon A. (2005) Managing grassland for production, the environment and the landscape. Challenges at the farm and the landscape level. Livestock Production Science (96): 11– 31.

Gohin, A (2006) Assessing CAP reform: Sensitivity of modelling decoupled policies. Journal of Agricultural Economics 57 (3): 415– 440.

Gottschalk T K, Dieko T, Ekschmitt K, Weinmann B, Kuhlmann F, Purtauf T, Dauber J and Wolters V (2007) Impact of agricultural subsidies on biodiversity at the landscape level. Landscape Ecology 22:643–656.

Gueydon A., Röder N. and Hoffmann H. (2007) Les terres collectives en Allemagne: l'exemple des Allmendes du sud de la Bavière. Leur intégration dans l'économie agricole. In Charbonnier, P., Couturier, P., Follainet, A. and Fournier P. (eds.): Les espaces collectives dans les campagnes XIe-XXIe siècle. Clermont Ferrand: 453-469.

Hanf C-H and Noell C (1989) Experiences with Farm Sample Models in Sector Analysis,. in: Bauer, S. and W. Henrichsmeyer (eds.): Agricultural Sector Modelling, Kiel: 103-111.

Kirchgessner M. (2004) Tierernährung; 11. Aufl.; Frankfurt a. M.. p. 608.

Lederbogen D, Rosenthal G, Scholle D, Trautner J, Zimmermann B and Kaule G (2004) Allmendweiden in Südbayern: Naturschutz durch landwirtschaftliche Nutzung. – Schriftenreihe Angewandte Landschaftsökologie (62). Münster. p. 469.

LEL (Landesanstalt für Ernährung und Landwirtschaft) (2009) Schlachtrinderpreise der letzten 10 Jahre .landwirtschaft-mlr.baden-wuerttemberg.de/servlet/PB/menu/1100704_l1/index.html. last update 04.03.2009.

Meyer-Aurich A, Herrmann M, Zander P (2003) Consideration of biotic environmental quality targets in agricultural land use - A case study from the Biosphere Reserve Schorfheide-Chorin. Agriculture, Ecosystems and Environment 98: 529-539.

Mittenzwei K, Fjellstad W, Dramstad W, Flaten O, Gjertsen A K, Loureiro M and Prestegard S P (2007) Opportunities and limitations in assessing the multifunctionality of agriculture within the CAPRI model. Ecological Indicators 7 (4): 827-838.

Official Journal L. Council Regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers (Official Journal L 270, 21/10/2003 P. 0001 – 0069).

Oñate J J, Atance I, Bardají I and Llusia D (2007) Modelling the effects of alternative CAP policies for the Spanish high-nature value cereal-steppe farming systems. Agricultural Systems 94 (2): 247-260.

Pacini C, Wossink A, Giesen G and Huirne R (2004) Ecological-economic modelling to support multi-objective policy making: a farming systems approach implemented for Tuscany. Agriculture, Ecosystems & Environment 102 (3): 349-364.

Pannell D. J. (2006) Flat Earth Economics: The Far-reaching Consequences of Flat Payoff Functions in Economic Decision Making. Review of Agricultural Economics (28): 553-566.

Pop I. and Artico M. (2009) Agricultural prices in 2008. epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-09-010/EN/KS-SF-09-010-en.PDF. last update 09.02.2009.

Roeder N (2007) Entwicklung und Anwendung eines agentenbasierten Landnutzungsmodells unter besonderer Berücksichtigung der Betriebsleitereinstellung; Dissertation at the TU-München Weihenstephan. mediatum2.ub.tum.de/node?id=624088. Freising. p. 227.

Roeder N, Gueydon A and Hoffmann H (2005) The Allmende system in the Bavarian Alps, Germany; p. 51 - 85 in Roeder, N., Gueydon, A. and Hoffmann, H. (eds.) (2005): Comparison of the economical sustainability of CLS, Common-land-use systems in potential CLS areas and non-co-operative large-scale grazing regimes; unpublished report; p. 148.

Roeder N, Kantelhardt J and Kapfer M (2006) Impact of the CAP reform on small-scaled grassland regions. Agrarwirtschaft 55 (5/6): 257-267.

Rosenzweig M L (1995) Species Diversity in Space and Time. Cambridge University Press, Cambridge.

Scheidegger C, Bergamini A, Lederbogen D, Fernandez F, Grandchamp A-C, Keller C, Mirek Z, Oksanen L, Paul W, Rosenthal G, Stofer S, Trautner J, Vanbergen A and Watt A (eds.) (2004) Biodiversity indicators for large scale grazing; unpublished report. p. 39.

Tranter R B, Swinbank A, Wooldridge M J, Costa L, Knapp T, Little G P J and Sottomayor M L (2007) Implications for food production, land use and rural development of the European Union's Single Farm Payment: Indications from a survey of farmers' intentions in Germany, Portugal and the UK. Food Policy 32 (5-6): 656-671.

van der Ploeg J. D. (2003) The virtual farmer – Past, present and future of the Dutch peasantry. Assen. p. 444.