Agri-Environmental Schemes and Grassland Biodiversity: Another Side of the Coin

by

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Abstract:

In this paper part of the existing Agri-Environmental Schemes (AES) of the European Union are evaluated by using data on county level instead of applying field studies. The attempt is made to disentangle the effects of AES on land management practice as well as land use on biodiversity. It is argued that subsidies as AES should promote environmental-friendly land use which, in turn, should lead to biodiversity conservation. First results show that AES promotes ecological land use rather than extensive agricultural practice. Furthermore, AES is predominantly allocated in biodiversity rich counties and not in counties with low biodiversity. Furthermore, no clear evidence is so far found that land use practice improves the biodiversity status.

Keywords: AES effectiveness, biodiversity, policy evaluation

JEL: Q18, Q58, R14

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1. Introduction

In the last years criticism about European Agricultural Policy (CAP) has become more prominent. Public discussion is mostly pointing to the fact that tax money in large sums is spent on a sector which only accounts for a small proportion of employment (2.6 of total labor force in 2001) and nearly no value adding in economic terms (0.9% of GDP in 2001) (El-Agraa 2004). In real terms, this means that € 55.0 bn are distributed among farms and agricultural related sectors as well as used for rural development in the European Union in 2008[1]. One argument for spending this high amount of money is that agriculture provides not only employment, in particular in rural areas, but also serves as caretaker for landscapes and provides ecosystem services, environmental protection and food security to the public (see e.g. Sklenar 2007). An additional argument put forward is, that without political intervention there is a rising risk that agriculture may intensify even more leading to a further decrease of biodiversity. But this may not only cause a valuable genetic loss (e.g. material for food crops or source for medicine). Biodiversity serves as insurance for ecosystem functioning, which in turn provides mankind with ecosystem services. The term ecosystem service hereby refers to services as nutrient cycling, water catchment regulation as well as aesthetic values or recreation (see Hanley/Shogren/White 2001). Furthermore, preserving (bio-) diversity means to enable freedom of choice, as individuals may choose from a set of diverse alternatives (Perrings et al. 2007). Biodiversity is thereby mostly defined as the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (UN 1993, p. 146). However, as this definition is not feasible for quantitative research, focus is set here on the abundance and distribution of taxonomic groups in grassland.

Assuming that there is a rationale for political interventions, a question to be answered is, if the instruments chosen are effective. Therefore, steady assessment is necessary, especially regarding subsidies as here tax money is spent on a public good. Within the framework of the EU subsidies for environmental issues Agri-Environmental Schemes (AES) are set up to provide incentives to agriculture to implement environmentally friendly practices which in turn should enhance or at least protect biodiversity. Although, the EU demanded national evaluation of the programs and their impact on the present flora and fauna, empirical studies so far yield different results and are mainly conducted on the field level. Therefore, a general

[1] The CAP is the biggest expenditure stake followed by the fund for sustainable growth with €46.9 billion while for example the fund for health, consumer rights, youth, culture and media encompasses only €615 million (EC 2008)

conclusion about the efficiency of AES is hardly to obtain. In the paper at hand, rather to rely on field studies, subject of the analysis are the counties of the German federal states of Bavaria and Thuringia in order to draw a more generalized picture of the effectiveness of AES. Additionally, it is aimed here to analyze whether AES changes agricultural modes towards biodiversity-friendly practices or conserves existing agricultural structures. Besides disentangling the effects of policy instruments (AES), agricultural methods and biodiversity, the analysis seeks further to incorporate social-economic and geographical characteristics into the analysis. Focus is set hereby on grassland diversity and measures to enhance or influence the same.

The paper is structured as follows: After providing an overview of theoretical and empirical papers seeking to explore the relationship of biodiversity, political measures and agricultural practices (section 2); the empirical analysis conducted here is introduced (section 3). Afterwards, the implications of the first results are discussed and future research question are identified (section 4 and 5).

2. Theoretical / Empirical Background

a. Biodiversity and policy intervention

In standard economic terms, biodiversity is referred to as superior good, i.e. with increasing income a rising demand for biodiversity protection should be observable. Accepting biodiversity as socially desirable due to ecosystem services on the one hand, but having in mind the “Tragedy of the Commons” (Gordon 1954; Hardin 1968) on the other hand, political interference seems to be justified. Though, by seeking to reduce market failure, the risk of state failure is increased. Following the notions of Buchanan & Tullock (1962) and Olson (1965), policy makers are rarely benevolent, but rather maximizing their individual utility. This means beside aspects of social welfare also issues like e.g. increasing chances of reelection or expanding own power/status entering their utility function. Furthermore, the available information on how to intervene is in general not complete; bounded rationality is a major problem in policy making regarding environmental issues (Venkatachalam 2008). Besides these more general problems of state interventions, next to public and politicians, the interests of bureaucrats (see Niskanen 1971) and lobby groups (from nature conservation as well as from the agricultural sector) are implemented in various degrees within the political legislation and raise the likelihood of state failure. The findings of Bouleau et al. (2009), for example, suggest that funding for monitoring ecological indicators is not allocated according to the performance of the indicator but rather in line with institutional goals. Only if the outcome of the indicator fits the goal of the institutions, funding was provided. On the side of the public sector, Hynes et al. (2008) find that special habitats (e.g., dry grassland) were favored in the distribution of subsidies, while other habitats (e.g., wet grassland) were nearly neglected by public funding. Furthermore, also regarding the Red List, which was implemented to conserve endangered species, evidence was found that it is used as political instrument and driven by interests of lobby groups within the political arena (Rawls/Laband 2004; Mahanty/Russel 2002). To summarize, although there is a legitimation for state intervention to set incentives to protect environmental goods, steady evaluation of the existing AES programs is necessary in order to reduce the likelihood of misallocation of public spending.

b. Policy measures (AES) and agricultural practice

So far, political reaction towards biodiversity loss is either ex-post (e.g., Red List) or ex-ante (e.g. AES). Regarding subsidies as AES, these are paid as incentive for farmers to apply environmental-friendly practice on their fields. Thus, in a second step, it should theoretically lead to a reduced biodiversity loss if not even to enhanced biodiversity abundance. However, Baylis et al. (2008) already point out that the European AES, compared their US-equivalence, have a wider scope. Their main concern appears to be to reduce negative externalities of agriculture and to redistribute income instead of increasing species abundance or protect rare species. As the EU demanded national evaluation of the programs and their impact on biodiversity, a variety of field studies exists. Hereby mostly agriculture modes (under / not under AES schemes) are compared by their biodiversity occurrence. Some authors (e.g. Kleijn et al. 2001; Feehan et al. 2005; Moonen/Bàrberi 2008) argue that due to a missing focus AES do not have any effects at all on the status of biodiversity. Others (e.g. Kleijn et al 2006; Kleijn/Sutherland 2003; Kohler et al. 2007; Merckx et al. 2009a; Roth et al. 2008; Rundlöf et al 2008), however, found that AES partly improved biodiversity. While some species seem to be favored by AES others were driven close to extinction. Thus, effects of AES seem to depend on species characterization (e.g. mobility, breeding/blossom time). Hence, regarding rare species, AES seems to have even a negative effect on their prevalence (Bisang et al. 2009; Konvicka et al. 2008), while considering common species, AES seems to enhance their abundance (Mayer et al. 2008). This already discloses a potential inefficiency of AES: instead of protecting rare species the common ones are supported.

Additionally to species' characteristics, features of the surrounding landscape may influence the effectiveness of AES as well. As AES yield on field scales landscape complexity are not taken into account. This approach of “one size fits all” seems to create inefficiencies of the measure (see Merckx et al. 2009b; Concepcion et al 2008; Rundlöf et al. 2008).

Most of the empirical studies so far are field studies which relate the observed biodiversity directly to AES. But as AES should incentives changes in land use practice, the question about effectiveness of AES is dependent on the question whether it subsidizes existing practice and serves as income redistribution (see Baylis et al. 2008) or whether it induces more biodiversity friendly land use practice. Therefore, it has to be separated between the effects of AES on agricultural practice and the impact of agricultural usage on the existing biodiversity. Referring to the first effect, the following hypothesis is set up:

H1: Policy measurements (AES) lead to an increase in environmental-friendly agricultural practice.

c. Agriculture and biodiversity

It is argued, that in the last century an intensification of agricultural production mode took place. At the same time a loss of biodiversity is recognized. As it seems obvious that both should be connected, a wide range of scientific research seeks to find out which agricultural instrument in particular connects land management practice and species’ richness. While some field surveys find, e.g., a negative relationship between bird abundance and intensive agriculture in general (Herzon et al 2008), other were not able to find a significant effect between land use method and species richness (e.g. Clough et al. 2007; Kragten/de Snoo 2008). Due to the empirical lack of prove between land practice method and biodiversity abundance, emphasize is also laid on the decisive positive role for the occurance of species of landscape elements (e.g. Burel/Baudry 2005, Sian Bates/Harris 2009), the fragmentation of the landscape (Dauber et al. 2003), the mobility of species (Merckx et al. 2009a) or the age of the grassland (Waesch/Becker 2009). Field management seems however to determine grassland species’ composition (e.g. Andrieu et al. 2007; Boutin et al. 2008; Petersen et al. 2006; Taylor/Morecroft 2009). Thus, it seems that land use practice changes rather the composition of species in an ecosystem by favoring one species over another. In other words: as some species seems to react positively on a land management measure (e.g. early mowing), another may be disturbed and thus react by reduced prevalence. Due to fragmentation of the landscape such effects may be balanced out by providing niches for several species. Furthermore, the seed bank of the grassland may also have an important influence on the observed species richness. As seed banks serve as storage room for seed over years, alteration in species abundance seems to underlie long-term influence. So the observed practice of one season or short-term changes in land management practices, respectively, should not lead to long-term change of species richness. It may, however, have an impact on the population size of each species per season as well on observed species composition. As the analysis measures long-term species abundance (see data section), the following relationship between biodiversity and agricultural practice is expected:

> *H2: Agricultural land use should have no observed long-term effect on biodiversity abundance*

d. Socio-economic influence

Agriculture is not only producing food but also serves as supplier and user of ecosystem services for the human species (Dale/Polasky 2007). Therefore, and due to the level of observation in this analysis, socio-economic influences should not be neglected. That human actions can modify the stability of the ecological fixed points is already modeled by Antoci et al. (2005) and Eichner & Pethig (2006). Additionally, in economics the effect of economy on biodiversity is mainly discussed within the framework of the Environmental Kuznets Curve (EKC), which proposes an inverse U- (or N)-shaped relation between economic growth and biodiversity loss (e.g. Harbaugh et al. 2002, Borghesi 2002, Mozumder et al. 2006). Although most studies found an impact of economic growth on biodiversity loss, the effect seems either taxa specific (Naidoo/Adamowicz 2001) or could be counteracted by ‘good’ institutions (e.g. Asafu-Adjaye 2003; Dietz/Adger 2003; Freytag et al. 2009). However, the quality of institutions is dependent on income (e.g. Rigobon/Rodrik 2005) Thus, while biodiversity and socio-economic variables may be negatively related due to e.g. effects of industrialization (sealing of soil or disconnecting landscapes, pollution), there may be a positive relation between biodiversity and ‘good’ institutions via income. Most of the studies providing empirical evidence so far are conducted on a state level due to data availability on institutional quality. Restricted by missing data regarding ‘good institutions’ on the county level, the analysis at hand concentrates on the negative direct effects of human influence on biodiversity status, although it is acknowledged that indirect positives effects may be counteract.

e. Geographic influence

Biodiversity in-situ depends on topography, soil, landscape elements (e.g. Marini et al. 2007; Aviron et al. 2007). From an evolutionary point of view, land management practice found today is due to geographic features and biodiversity present in former times (e.g. Iron age) (see Olsson/ Hibbs 2005; Norton et al. 2009). Thus, geographical features seem to influence land management practice as well as species abundance on a long-term base. Furthermore, spatial clustering of ecological farming can be found (Parker/Munroe 2007) which has a positive effect on biodiversity enhancement (Rundlöf et al. 2008). Neighboring effects occur. Thus, in order to control for such effects, geographic features as well as spatial correlation needs to be included in the analysis as control variables.

To summarize, if AES is effective it should enhance the biodiversity status, especially in areas where low biodiversity can be found. Ideally, AES should be set up in such a way that alterations in land use are long-term and in favor of biodiversity-friendly agricultural methods. Thus, in the analysis at hand, it should be explored closer in a first step the factors which determines the allocation of AES. Secondly, it is aimed to disclose if AES alters land use intensity. In a third step, land use practice is related towards biodiversity in order to see what kind of land use practice is connected with the level of biodiversity. Figure 1 shows graphically the analytical framework the empirical analysis is embedded in.

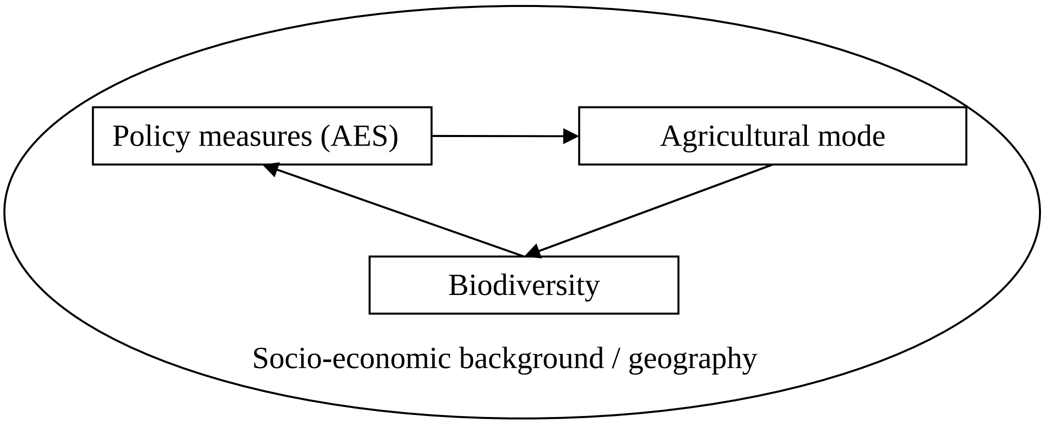

Figure 1: Systematic illustration of the analysis (own display).

3. Empirical Analysis

a. Data

To analyze the efficiency of AES several indicators on a county level for the German federal states of Bavaria and Thuringia are collected. Thereby, cities were explicitly excluded as agriculture plays here seldom an important role. We expect further that ‘city-biodiversity’ encompasses other species than our common grassland species. Thus analysis may be disturbed. The analysis is restricted towards grassland as data is available for different taxonomic groups of this ecosystem. Additionally, grassland serves well as model system in biodiversity research.

- **Biodiversity:**

In order to measure biodiversity, firstly, the Shannon Diversity Index (*SHDI*) for the distribution of orchids in the counties of Bavaria and Thuringia is calculated as follows:

$$SHDI = -\sum_{i=1}^{J}(P_i \times \ln P_i)$$

in which J denotes the number of species and P the relative density of species i in the respective county (i.e. $P = n_i/N$). Hereby, data for the distribution of the orchid species are based on Korsch et al. (2002) for Thuringia and Schönfelder et al. (1990) for Bavaria. Although the Shannon Diversity Index performs well compared to other indices (Buckland et al 2005), it is only an evenness indicator. In order to test for robustness of the findings an additional indicator is included. The following variables are bundled in one variable *biodiversity* with the help of a main component analysis[2]: (1) the number of typical grassland plant species (based on Korsch et al. (2002) for Thuringia; Schönfelder et al. (1990) for Bavaria); (2) the number of common butterfly species (based on Thust et al. (2006) for Thuringia, and Voith et al. (2007) for Bavaria); (3) the number of common grasshopper species (based on Köhler 2001 for Thuringia and Schlumprecht/Waeber (2003) for Bavaria); (4) number of typical grassland bird species (based on Nicolai (1993) for Thuringia and Bezzel et al. (2005) for Bavaria); and (5) the number of common orchid species (based on Korsch et al. (2002) for Thuringia and Schönfelder et al. (1990) for Bavaria). Focus is here set on common species, i.e. species which occur in Thuringia and Bavaria. Thus, species specific for e.g. landscapes as the Alps are excluded. Furthermore, all variables are standardized (mean = 0, standard deviation = 1) and related to the size of grassland (hectares) within the county. Both indicators, SHDI and biodiversity, capture the evenness in species distribution and species richness. The interdependency between taxonomic groups cannot be integrated due to data availability. Limits in the efficiency of this type of indicator, as pointed out by e.g. Büchs et al. (2003), are acknowledged. However, as several taxonomic groups are integrated into the analysis, distortion in the findings due to species characteristics (e.g. mobility – see Merckx et al. 2009b) can be ruled out.

[2] The loading can be found in Table 4 (see Appendix).

- **Policy:**

AES is here measured as the amount of agricultural area subsidized under the Landscape-Program KULAP C for Thuringia and the Contractual Nature Conservation Program (VNP) and Compensation Scheme for FFH-area (EA-FFH) for Bavaria in 2006. Although differences in the implementation of EU-Programs exist, both programs encompass similar measures and are as such comparable. KULAP C as well as VNP/EA-FFH promote extensive grassland usage and landscape fragmentation (by inducing e.g. field stripes or hedgerow) in areas especially highly valuable for nature conservation practice. Furthermore, they require higher nature conservation efforts than the Landscape-Program KULAP A-B, which subsidizes extensive agriculture in broader spectrum. So, although KULAP C and VNP/EA-FFH are only a small fraction of the EU-AES, it is the important one for nature conservation[3].

- **Agricultural land use:**

Agricultural intensity is here measured in relative terms as *grassland ecological used* as stated in the "Agrarstrukturerhebung 2007[4]" of the Federal Statistical Office. However, the term 'ecological agriculture' implies that the farmer took the effort to comply to land management standards and with this registered officially under EU control (EWG regulation 2092/91). As the size of grassland managed according to this regulation is relatively small (mean 6 percent of county's grassland), additional measurements are applied. One is the *grazing intensity* which shall capture the size of intensively used grassland. Therefore, data from the "Agrarstrukturerhebung 2007" of the Federal Statistical Office are used to compute an intensity measure per farm. Hereby, the farm livestock typically kept outdoor on grassland (mother cows (older than 2 years), number of sheep and number of horses, measured in animal units) are set relatively towards the grazing area the farm is occupying. This intensity measure is then used to calculate the amount of hectares per county occupied with a grazing intensity above 2 livestock units per hectare (GV/ha). In the EU-programs for AES, or extensive agriculture respectively, the threshold is 1.4 GV/ha. However, this number is applied differently by the German federal states. While some federal states use 1.4 GV/ha related to forage area in total irrespectively of the usage, others translate livestock units into

[3] In Bavaria in 2005 and 2006 VNP/EA-FFH was distributed by the Ministry for Nature Conservation, while KULAP A-B is allocated by the Ministry of Agriculture.

[4] "Agrarstrukturerhebung" is a survey of the Federal Statistical office conducted all four years whereby all farms within Germany are obliged to answer questions about e.g. cultivation, employment and asset structure.

roughage consuming livestock relatively to forage area (RGV/ha) by implementing individual translation keys. Here, 2 GV/ha is used as threshold as it implies very intensive usage of the grassland[5].

A third indicator in order to test for robustness of the result is the amount of livestock in the county relative to the county's grassland based as well on the data provided by the "Agrarstrukturerhebung 2007" of Federal Statistical Office. This indicator is not directly related towards grassland usage, but rather displays general agricultural intensity in the county.

To proxy the change in land use, the same variables are calculated from the "Agrarstrukturerhebung 2003" of Federal Statistical Office. As both surveys should be comparable, according to the Federal Statistical Office, the alteration in land use is calculated as the difference of the indicators 2007 and 2003. Data of the AES program is dated to 2006. But, as the AES framework as such was set up for the years 2003-2006, the measurements subsidized are relatively constant over this time period which leads to the assumption that irrespectively of the amount of subsidized area the impact of the policy measures as such introduced in 2003 and continued until 2006 should be observable in the difference of land management practice between 2003 and 2007. Thus, change in land use is here the situation in agricultural practice before and after the AES scheme 2003-2006.

Additionally, the difference of arable land used in 2003 and 2007 is taken out from the "Agrarstrukturerhebung". These figures are used in order to proxy general change in agricultural land use.

- **Socio-economic control**

In order to reduce statistical issues like multicollinearity, the socio-economic control is limited towards the variable of settlement- and traffic area of 2004 according to the Federal Statistical Office. It is argued that this figure captures best the effects of economic development like sealed soil or industrialization. Additionally, this variable is highly correlated (on a 70-80% level) with population density and GDP in the county.

- **Geography control**

To control for geographical on-site impacts again several variables are bundled together as geography. So, with the help of a main component analysis the following variables are integrated: (1) the average altitude of the county according to the Bavarian State Office for

[5] Using the threshold of 1.4 GV/ha does not lead to different results (not reported here).

Environment and the Thuringian State Office for Environment and Geology; (2) the mean monthly temperature (obtained by the German Weather Service); (3) the mean monthly precipitation (obtained by the German Weather Service); and a (4) the Alps-Dummy, a variable denoting 0 for counties dominated by the Alps and 1 for No-Alps-Counties in order to foreclose specific features of the landscape Alps[6].

Additionally, a proxy for soil quality as used for tax purposes (EMZ) (obtained from the Bavarian Treasury Ministry and Thuringian Ministry of Finance) serves as additional geographic indicator.

Clustering effects should be captured by a distance matrix, integrated in the analysis (see method section). Furthermore, a dummy variable is introduced which shall capture systematic differences between Bavaria and Thuringia (1=Bavaria, 0 = Thuringia) in particular regarding the history of agricultural land use practice which are still prevalent nowadays.

An overview of the variables and their statistical properties is attached as Table 6 in the Appendix.

b. Method

Mapping the above mentioned data, spatial clustering already becomes obvious, for example, for the occurrence of biodiversity but also for land use practice (see Appendix: Figure 2 – Figure 7). The observed clustering may have different sources like geographical features (e.g. common landscapes, climate) or neighboring effects (spillover or contagion effects). Based on the fact that global Moran's I as well as Geary's C, both tests for spatial autocorrelation, point to significant global spatial autocorrelation for most of the dependent variable spatial lag regression seems to be justified. In the analysis a spatial lag model with global autocorrelation is applied, captured by the following formula:

$$y = \mathbb{X}\beta + \rho\mathbb{W}y + \epsilon \text{ with } \epsilon \sim N(0, \sigma^2 \mathrm{I})$$

in which $\mathbb{W}$ denotes a weighting matrix and y the spatially lagged dependent variable additional to $\mathbb{X}$ the observed characteristics of the county and the coefficients β & ρ (following Anselin 2001). Hereby the weighting matrix is a distance matrix whereby weights are calculated as inverse of the distance between the centres of each county to the others. Thus, the further away the counties of each other the less probably may be spillover or contagion effects and the less likely that these counties share similar landscapes. Variables

[6] The loading can be found in Table 5 (see Appendix).

which seem to be not affected strongly by distance weights, but rather show only hints of local spatial autocorrelation are the changes in agricultural modes. So, for them spatial error regressions with robust standard errors are calculated in the form of:

$$y = \mathbb{X}\beta + \lambda\mathbb{W}\xi + \epsilon \text{ with } \epsilon \sim N(0, \sigma^2 \mathrm{I})$$

In which the error term is separated into $\lambda\mathbb{W}\xi$ and ϵ, where $\lambda\mathbb{W}\xi$ captures the spatial dependence. Thus, in contrast to the spatial lag model, the coefficient is corrected for spatial correlation by integrating spatial dependence in the error term.

To test for multicollinearity, the variance inflation factor is calculated and regressions are dismissed with a factor above 6 (see Hill & Adkins 2001). Furthermore, robust standard errors are calculated in order to reduce the disturbance of the analysis by outliers and statistical issues as heteroskedasticity of the data. As the regression encompasses variables bundled by main component analysis, all variables in the regressions are standardized (mean = 0; standard deviation = 1) to ensure robust results.

In the first step of the analysis, AES is related towards land use practice. Hereby, the variables SHDI and biodiversity are included in order to consider whether AES allocation is related with biodiversity abundance. Control is further taken for socio-economic variables as well as geographic feature in order to capture whether particular regions are favored by AES. In a second step, changes in land use between 2003 and 2007 are sought to be explained by the AES scheme of 2003-2006 (data of 2006 used) as well as general changes in agriculture in this time period. Socio-economic and geographic controls are implemented as well as the Bavarian-Dummy. The third analysis concentrates on the abundance of biodiversity and whether land-use practice present in 2007, socio-economic control or geographic variables are able to explain the difference in richness and evenness. The Bavarian-dummy is included to catch systematic differences between Thuringia and Bavaria.

c. Results

Regarding the first analysis, in which AES is under examination (see Table 1**Fehler! Verweisquelle konnte nicht gefunden werden.**), results of the spatial lag regression show a positive relationship between AES allocation and the two biodiversity indicators (evenness and abundance). Thus, further evidences are provided that AES payments promote rather the richness and even distribution of common species instead of rare species. Furthermore, incorporated together with species richness into the regression, evidence is found that ecological land use is supported significantly by AES (positive coefficient) and general agricultural intensity is reduced by AES (negative coefficient). Regarding grazing intensity, the significant effect shown here seems to be created by incorporating biodiversity into the regression. As soon as the two biodiversity variables are excluded from the analysis, significant effects between AES and grazing intensity dissolve; while other significant effects remain (results are not reported here). In regard to the control variables, the Thuringian subsidy practice does not significantly differ from the Bavarian ones as in all regressions the Bavarian-Dummy showed no significant effect. The other controls do not give further insights.

	AES	AES	AES	AES	AES	AES
SHDI	**0.267*** **	**0.291*** **	**0.188*** **			
	(0.0775)	(0.0751)	(0.0724)			
Biodiversity				**0.312*** **	**0.426*** **	0.0611
				(0.0971)	(0.119)	(0.126)
Ecological grassland	0.206			**0.284** **		
	(0.143)			(0.133)		
Grazing intensity		0.128			**0.304*** **	
		(0.109)			(0.106)	
GV/ha			**-0.449*** **			**-0.495*** **
			(0.138)			(0.159)
Settlement area	-0.0683	-0.0434	-0.109	**-0.186* **	**-0.176* **	-0.145
	(0.0843)	(0.0887)	(0.0901)	(0.0984)	(0.103)	(0.0932)
Geography	-0.162	-0.0852	0.116	-0.0472	0.103	**0.198* **
	(0.147)	(0.130)	(0.120)	(0.147)	(0.118)	(0.110)
Bavaria-Dummy	-0.404	-0.562	-0.301	-0.150	-0.261	-0.207
	(0.343)	(0.344)	(0.413)	(0.360)	(0.384)	(0.426)
Constant	0.319	0.447	0.238	0.113	0.203	0.161
	(0.293)	(0.301)	(0.347)	(0.310)	(0.334)	(0.365)
rho	0.622*	0.602*	0.361	0.706***	0.668**	0.503
	(0.325)	(0.343)	(0.507)	(0.267)	(0.301)	(0.426)
sigma	0.822***	0.833***	0.790***	0.817***	0.812***	0.805***
	(0.0959)	(0.0984)	(0.0866)	(0.0977)	(0.102)	(0.0876)
Observations	88	88	88	88	88	88
Wald	3.668	3.083	0.506	7.009	4.926	1.393
chi2	28.22***	24.48***	34.51***	26.95***	26.20***	28.86***

Table 1: Spatial Lag Regression with AES as dependent variable and present agricultural practice as independent variable

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

In order to explore whether AES induces changes in land management practice spatial error regressions with changes between the years 2003 and 2007 in agricultural practice as dependent variable and AES as independent are conducted. A significant positive relationship is found regarding the prospect of receiving AES in 2006 and changing land use practice between 2003 and 2007 (see ***Table 2***). In respect to the validity of the model, it should be rejected (e.g. chi-square values could not be computed and Wald-Statistic is low). Thus, the change in land use cannot be explained by the variables so far implemented in the analysis.

	Difference grazing intensity 03-07	Difference ecological used grassland 03-07	Difference GV/ha 03-07
AES	**0.279***	**0.350*****	**0.276*****
	(0.154)	(0.121)	(0.0912)
Settlement area	**0.256****	0.0111	0.132
	(0.107)	(0.0627)	(0.142)
Geography	0.189	-0.0434	0.175
	(0.150)	(0.111)	(0.147)
Bavaria-Dummy	-0.291	**-0.549*****	**-0.653***
	(0.291)	(0.165)	(0.365)
Difference grassland 03-07	**0.320***** (0.116)	0.0820 (0.0748)	
Difference arable land 03-07			**-0.143**** (0.0573)
Constant	0.236	0.449***	0.536
	(0.264)	(0.143)	(0.417)
lambda	-1.220	-4.940***	0.572
	(1.161)	(1.389)	(0.458)
sigma	0.834***	0.716***	0.900***
	(0.181)	(0.173)	(0.106)
Observations	88	88	88
Wald	1.105	12.65	1.559
chi2	e(chi2)	e(chi2)	e(chi2)

Table 2: Spatial Error Regression with change in agricultural practice as dependent variable and AES as independent variable

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Note: Ordineary-Least-Square Regression leads to similar results.

Plotting these variables against each other, it becomes obvious, that there is a strong clustering of slight changes in land use and low payment of AES which drives the positive relationship between changes in land use and AES payment (see **Fehler! Verweisquelle konnte nicht gefunden werden.** in Appendix). Additionally, these figures of changes in land use should be interpreted carefully, as regarding the data of the surveys of 2003 and 2007 of the ‘Agrarstrukturerhebung’, a general decrease of arable land is observable (average -404.19 ha; median -250.71 ha), hereby also the grassland usage changed with in average decline of about 101.74 ha (median -11.89 ha) for mowing and in average 52.29 ha (median -4.96 ha) for grazing. These general developments, however, show low impact on the agricultural land use mode. Hectares used with high grazing intensity (more than 2 livestock (GV) / ha) decreased in these four years in average of about 0.078 hectare (median -1.165 ha), while ecological used grassland in average stayed on the relative same level (average difference: 0.004; median: 0.009 of ecological used grassland as fraction of total amount of grassland between 2003 and 2007). Thus, the results are very likely to be driven by external trends instead of caused by AES. This is bolstered up by the result, that the Bavarian dummy is not significant regarding grazing intensity and shows a systematic lower rate of change for

Bavaria towards ecological farming, although the rate of change within four years is already low. So, the answer referring to hypothesis 1 so far is that AES does not significantly promote a change in land use practice. This is caused firstly by the “stickiness” of agricultural practice, i.e. hardly any change in respect to intensity is observable. If there is change, other factors, not included into the analysis, seems to drive this alteration in land use practices.

Further regressions are conducted to link biodiversity and the mode of land use. Hereby the diverse biodiversity indicators are implemented as dependent variable (see Table 3). First results show no significant relation of biodiversity towards ecological agriculture. The distribution of orchid species, though, seems to be connected positively with ecological land use. In general intensive agricultural (GV/ha) land use reduces the occurrence of biodiversity (negative coefficient), while grazing intensity only seems to effect species richness but not the evenness of orchid species distribution. According to our hypothesis 2, it seems that long-term effects of this land use are already observable. Thus, hypothesis 2 has to be declined.

	SHDI	**SHDI**	**SHDI**	**Biodiversity**	**Biodiversity**	**Biodiversity**
Ecological used grassland	**0.176****			-0.126		
	(0.0880)			(0.0949)		
Grazing intensity		0.128			**-0.312*****	
		(0.0814)			(0.0804)	
GV / ha			**-0.493*****			**-0.630*****
			(0.105)			(0.0924)
Settlement area	-0.172	-0.157	**-0.215****	**0.247***	**0.218***	0.164
	(0.115)	(0.117)	(0.0948)	(0.133)	(0.131)	(0.101)
EMZ	0.153	**0.181***	**0.216****	**0.344*****	**0.311*****	**0.361*****
	(0.0969)	(0.0990)	(0.0936)	(0.131)	(0.115)	(0.121)
Bavaria-Dummy	0.137	0.0129	0.389	**-0.599***	**-0.585****	-0.0268
	(0.318)	(0.300)	(0.292)	(0.322)	(0.260)	(0.274)
Geography	0.120	**0.199****	**0.431*****	-0.0653	-0.135	**0.120***
	(0.0999)	(0.0994)	(0.0920)	(0.103)	(0.0946)	(0.0655)
Constant	-0.109	-0.00838	-0.312	0.471	0.459*	0.0186
	(0.278)	(0.253)	(0.266)	(0.289)	(0.240)	(0.241)
rho	0.791***	0.796***	0.757***	0.764***	0.771***	0.184
	(0.200)	(0.197)	(0.233)	(0.212)	(0.203)	(0.488)
sigma	0.894***	0.899***	0.834***	0.753***	0.699***	0.629***
	(0.0607)	(0.0619)	(0.0618)	(0.104)	(0.0898)	(0.0923)
Observations	88	88	88	88	88	88
Wald	15.58	16.33	10.55	13.03	14.46	0.142
chi2	27.81***	19.89***	74.54***	31.98***	37.72***	96.09***

Table 3: Spatial Lag Regression with SHDI & Biodiversity as dependent variable
Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Referring to the geographic control variables, biodiversity abundance is significantly positive related with the soil quality (EMZ). The Bavaria dummy is as well significant for the the biodiversity indicators which indicates a significant systematic difference between Bavarian and Thuringian biodiversity level, whereby in Bavaria a lower abundance of taxonomic groups are found than in Thuringia's landscapes. Taking additionally our model specification towards spatial autocorrelation (rho, sigma, lambda), one clear finding is that geographical features as well as neighborhood or distance matters.

4. Discussion

So far conducted empirical analysis unveils that the present AES schemes for nature conservation rewards ecological land use. However, no causality can be drawn so far by the existing dataset; in other words, it might be that AES is just compensating farmers for using ecological methods already in practice instead of incentivizing it. Thus, these farmers may have applied ecological methods irrespectively of the AES. The subsidy provided under this scheme may just influence positively the cost-effectiveness structure (see also Matzdorf/Lorenz 2009). Furthermore, in case AES promotes ecological land use, there is still a lack of empirical evidence in county level studies (here) as well as field studies that ecological agriculture positively affect biodiversity conservation and enhancement. An additional line of criticism towards AES is put forward by Kleijn & Sutherland (2003). They found in their comparisons of the effect of AES measures across Europe, that the schemes are taken up mainly in areas with historically high extensive agriculture and high biodiversity, but rather seldom in areas with low biodiversity occurrence or/and intensive farm practices. In the analysis at hand, it is also found that regions with a high number of common species are supported rather than regions with low rates of biodiversity which may improve. So far, regarding field study results evidence for a positive effect of AES is dependent on the species or/and on its characterization. Thus, the general picture would lead to the conclusion that different land use practices are leading to various outcomes in the meaning that some species will be favored and some will be neglected if not even disadvantaged. This would lead to the general conclusion that a subsidy framework as AES in general is not able to enhance biodiversity as such, but rather needs to be focused and long-term orientated. However, to set focus leads unavoidable to the questions which species to preserve and what is a species valid in monetary terms (see Weitzman 1998; Metrick/Weitzman 1998) or if landscape fragmentation measure are more effective in conserving/enhancing biodiversity than environmental-friendly agriculture. Thus, AES schemes should rather incentives hedges or field stripes than ecological land use in general. This latter argument may also explain why we find a positive connection of biodiversity abundance, agricultural practice and AES. Our AES indicator consists predominantly of measures incentivizing the creation of landscape elements. Thus, further research needs to focus if this positive relation still holds if rare species or AES with broader spectrum (in particular KULAP B) are subject of analysis.

To conclude, so far, first results show a positive impact of AES on promoting ecological land use (however not on extensive land use). Regarding the induced change of agricultural practice, it seems difficult to lead to alteration. In particular, if one examines the rate of changes in agricultural usage between 2003 and 2007, nearly no difference is observable within these four years. A 'stickiness ' of land use mode seems to be prevalent, which is also already pointed out by Ohl et al. (2008), who model cases where the payment scheme requires overcompensation of the land users to be effective. This in turn means that increasing the level of AES may be effective in promoting ecological land use, but may not be efficient or socially justified. However, as political interventions and compensation in the agricultural sector is common for years now, an open question remains what may have happened without AES.

Furthermore, it seems that intensive agriculture is prevalent in biodiversity rich regions which also yield high in terms of soil quality. Taking together the low rate of change in agricultural practice and the prevalent biodiversity abundance, it seems that although AES promotes ecological agriculture, no observable effect in biodiversity conservation is measurable in terms of biodiversity enhancement. Additionally, biodiversity is here measured in terms of common species. The effect of AES on rare species shall be subject to further research.

5. Literature

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Appendix

Table 4: Factor Loadings of the Main Component Analysis for the Variable "biodiversity"

	Component
	Biodiversity
Z-Value (Plants/ha)	0.988
Z-Value (Butterflies/ha)	0.982
Z-Value (Grasshoppers/ha)	0.985
Z-Value (Birds/ha)	0.985
Z-Value (Orchids/ha)	0.966

Explained variance: 96,299 percent

Table 5: Factor Loadings of the Main Component Analysis for the Variable "geography"

	Component
	Geography
Alps-Dummy	-0.860
Z-Value (Altitude)	0.967
Z-Value (Temperature)	-0.866
Z-Value (precipation)	0.962

Explained variance: 83,757 percent

Table 6: Overview of all variables

Abbreviation	**Description**	**Descriptive statistic**
AES	Fraction of grassland subsidized under the EU – Scheme of KULAP C in Thuringia and VNP/EA-FFH in Bavaria in 2006 in hectare (see Figure 4) *Source: Bavarian Ministry for Environment; Thuringian Ministry for Administration*	Min: 0 Max: 0.4965 Mean: 0.0954 Std. Dev.: 0.1049
Alps-Dummy	Dummy with 1 for counties not dominated by the Alps (78) and 0 for counties dominated by the Alps (10)	
Altitude	Mean altitude of the county in 2009 *Source: Bavarian State Office for Environment and the Thuringian State Office for Environment and Geology*	Min: 183.421 Max: 1122.596 Mean: 479.1243 Std. Dev.: 174.7127
Bavaria-Dummy	Dummy variable with 1 for county in Bavaria and 0 for county in Thuringia	
Birds / ha	Number of grassland bird species to be found in the county of a sample of 35 typical grassland bird species, i.e. birds breeding in grassland or nourish crucially in grassland per county relative to the county's grassland *Source: Bavaria: Bezzel et al (2005), Status 1996-1999; Thuringia: Nicolai (1993), Status 1978-1982*	Min: 0.0003 Max: 0.0146 Mean: 0.0032 Std. Dev.: 0.0026
Butterflies / ha	Number of butterfly species to be found in the county of a sample of 98 common species relative to the county's grassland *Source: Bavaria: Voith/Bolz/Wolf (2007); Status up from 1971; Thuringia: Thust et al. (2006), Status 1991-2002*	Min: 0.0011 Max: 0.0360 Mean: 0.0079 Std. Dev.: 0.00601
Difference ecological farming	Difference between percent of grassland used ecological in 2007 to percent of grassland used ecological in 2003 (see Figure 6) *Source: Agrarstrukturerhebung 2003 and 2007*	Min: -0.0378 Max: 0.2635 Mean: 0.0097 Std. Dev.: 0.0324

Difference grazing intensity	Difference between grassland area used with an grazing intensity above 2 livestock (mother cows older than 2 years, horses and sheep) per hectare grazing land per farm in 2007 to grassland fraction used in 2003 with grazing intensity above 2. *Source: Agrarstrukturerhebung 2003 and 2007*	Min: -147.24 Max: 425.94 Mean: 0.0782 Std. Dev.: 61.3916
Difference GV/ha	Difference between total livestock in the county per ha grassland in 2007 in livestock units / hectare and the same in 2003 *Source: Agrarstrukturerhebung 2007*	Min: -1.9581 Max: 0.2463 Mean: -0.2798 Std. Dev.: 0.2993
Ecological grassland	Fraction of grassland used under ecological standards of the EWG regulation 2092/91in 2007 (see Figure 5) *Source: Agrarstrukturerhebung 2007*	Min: 0.0014 Max: 0.2701 Mean: 0.0644 Std. Dev.: 0.0480
EMZ	Ertragsmesszahl – number given by tax authority in order to evaluate the potential quality (profit) of the soil in 2007 *Source: Bavarian Treasury Ministry and Thuringian Ministry of Finance*	Min: 28.51 Max: 63.39 Mean: 42.9635 Std. Dev.: 8.3584
Grasshoppers / ha	Number of grasshopper species to be found in the county of a sample of 51 common species relative to the county's grassland *Source: Bavaria: Schlumprecht/Waeber (2003), Status up from 1986; Thuringia: Köhler (2001), Status 1980-2000*	Min: 0.0005 Max: 0.0208 Mean: 0.0044 Std. Dev.: 0.0036
Grassland	Area used as grassland in percentage of arable land in 2007 *Source: Agrarstrukturerhebung 2007*	Min: 0.0353 Max: 0.9829 Mean: 0.3373 Std. Dev.: 0.2371
Grazing intensity	Relative meadow area used with an grazing intensity above 2 livestock (mother cows older than 2 years, horses and sheep) per hectare grazing land per farm in 2007 in hectare *Source: Agrarstrukturerhebung 2007*	Min: 9.49 Max: 574.62 Mean: 144.0852 Std. Dev.: 92.6137
GV / ha	Total livestock in the county per ha grassland in 2007 in livestock units/ha *Source: Agrarstrukturerhebung 2007*	Min: 1.1143 Max: 10.2168 Mean: 3.2839 Std. Dev.: 1.9025
Orchids / ha	Number of orchid species to be found in the county of a sample of 34 common orchid species relative to the county's grassland *Source: Bavaria: Schönfelder et al. (1990), Status 1945-1986; Thuringia: Korsch et al. (2002), Status 1990-2001*	Min: 0.0003 Max: 0.0096 Mean: 0.0019 Std. Dev.: 0.0016
Plants / ha	Number of common grassland plants to be found in the county of a sample of 162 typical grassland plant species relative to the county's grassland (see Figure 3) *Source: Bavaria: Schönfelder et al. (1990), Status 1945-1986; Thuringia: Korsch et al. (2002), Status 1990-2001*	Min: 0.0023 Max: 0.0682 Mean: 0.0171 Std. Dev.: 0.0126
Precipitation	Average of monthly mean of precipitation in millimeter for the years 1961-1990 for Bavaria and 1971-2000 for Thuringia *Source: DWD*	Min: 519.6856 Max: 1890.13 Mean: 894.9913 Std. Dev.: 280.609

Settlement area	Fraction of settlement and traffic area of total county area on 31.12.2004 (see Figure 7) *Source: Federal Statistical Office*	Min: 4.4 Max: 18.2 Mean: 9.8838 Std. Dev.: 2.4748
SHDI	Shannon diversity index for orchids (Status 1945-1983 in Bavaria; 1990-2001 in Thuringia) (see figure 1) *Based on data provided by: Schönfelder et al. (1990) for Bavaria (Status 1945-1983); Korsch et al. (2002) for Thuringia (Status 1990-2001)*	Min: 1.6582 Max: 2.9865 Mean: 2.4501 Std. Dev.: 0.3389
Temperature	Average of monthly mean of the daily temperature in degree Celsius for the years 1961-1990 for Bavaria and 1971-2000 for Thuringia *Source: DWD*	Min: 0.6777 Max: 8.6408 Mean: 6.1982 Std. Dev.: 2.7386

*Please note: Number of observations are always 88.

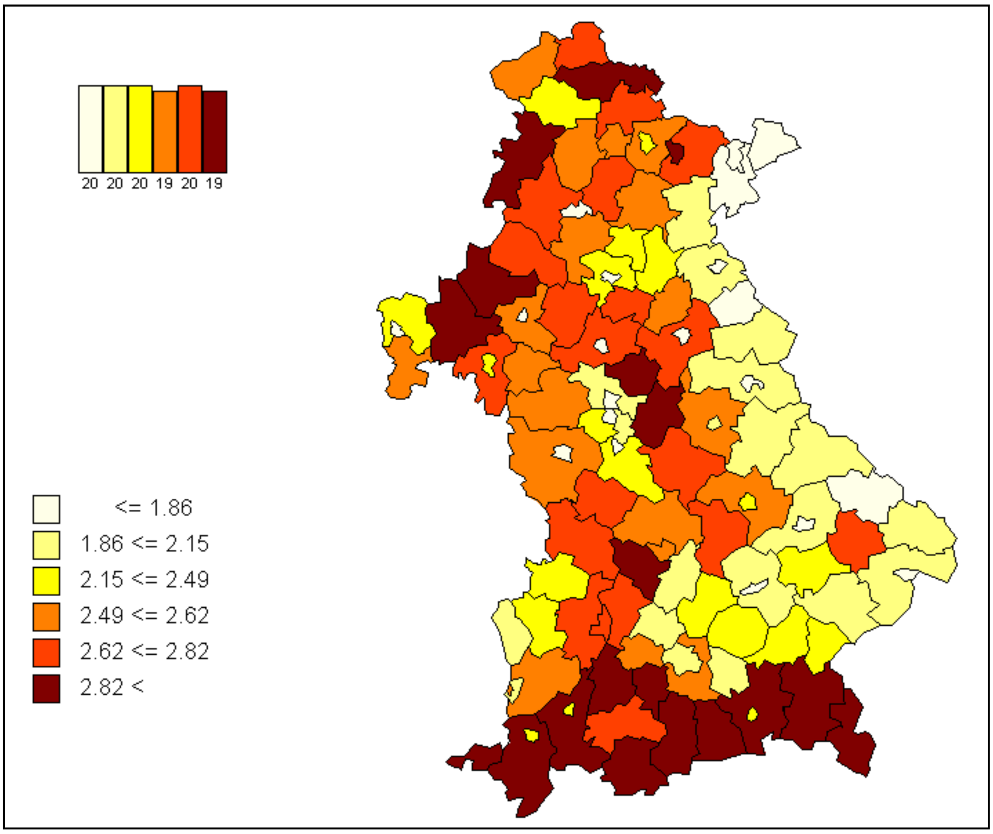

Figure 2: SHDI for Orchids on a county level in Thuringia and Bavaria

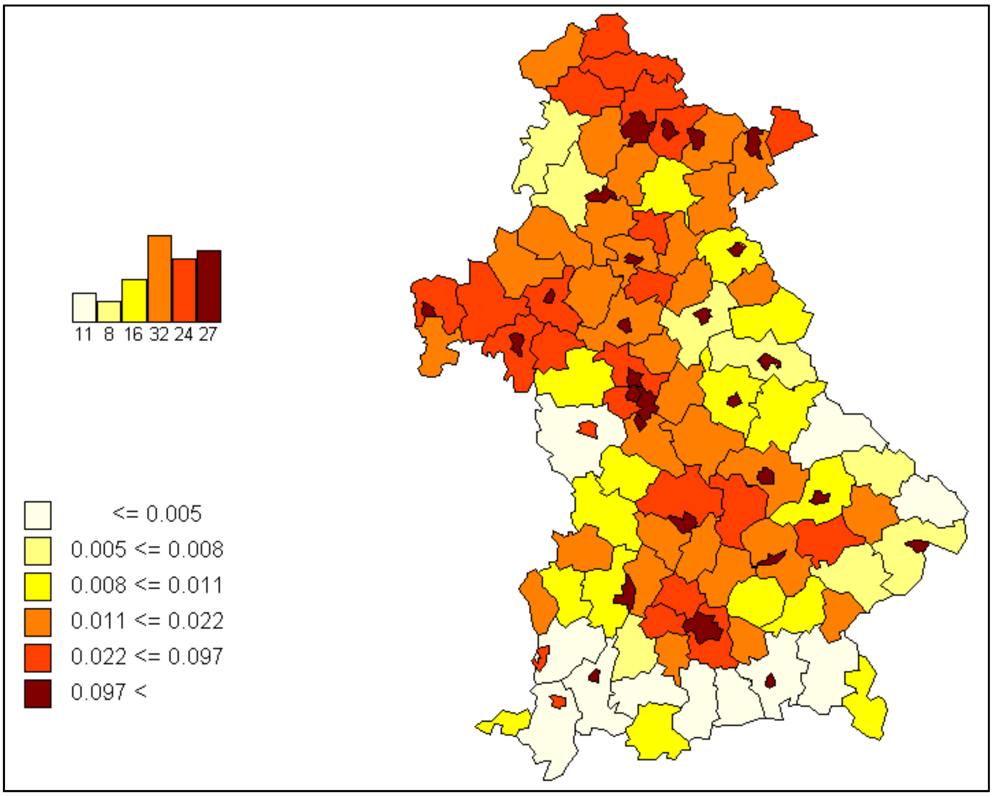

Figure 3: Distribution of typical grassland plant species per hectare grassland on a county level for Bavaria and Thuringia

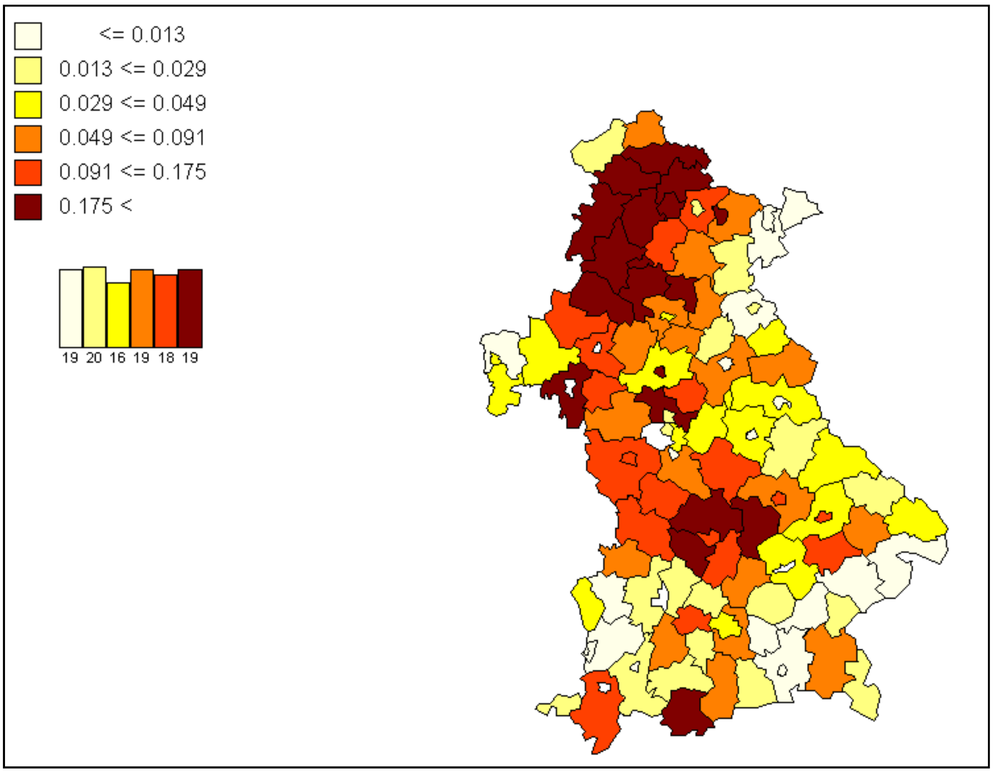

Figure 4: Distribution of subsidized grassland under KULAP C or VNP/EA-FFH relative to total grassland in the respective county

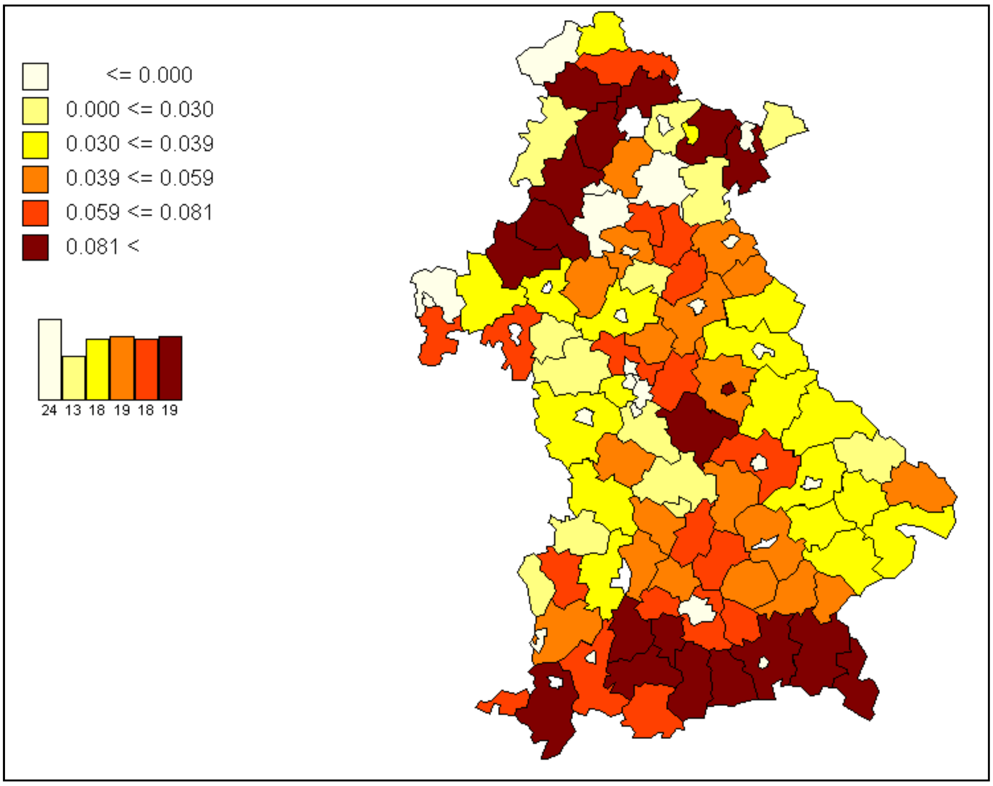

Figure 5: Distribution of ecological used grassland as proportion of total grassland on a county level

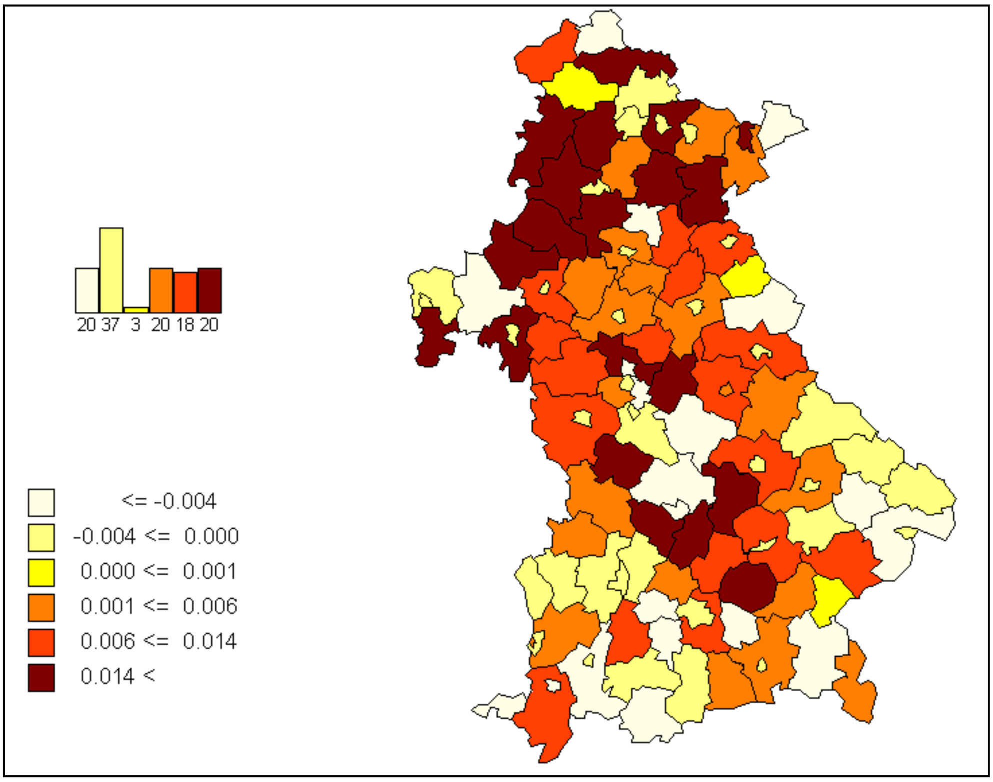

Figure 6: Difference of ecological grassland in 2007 towards 2003

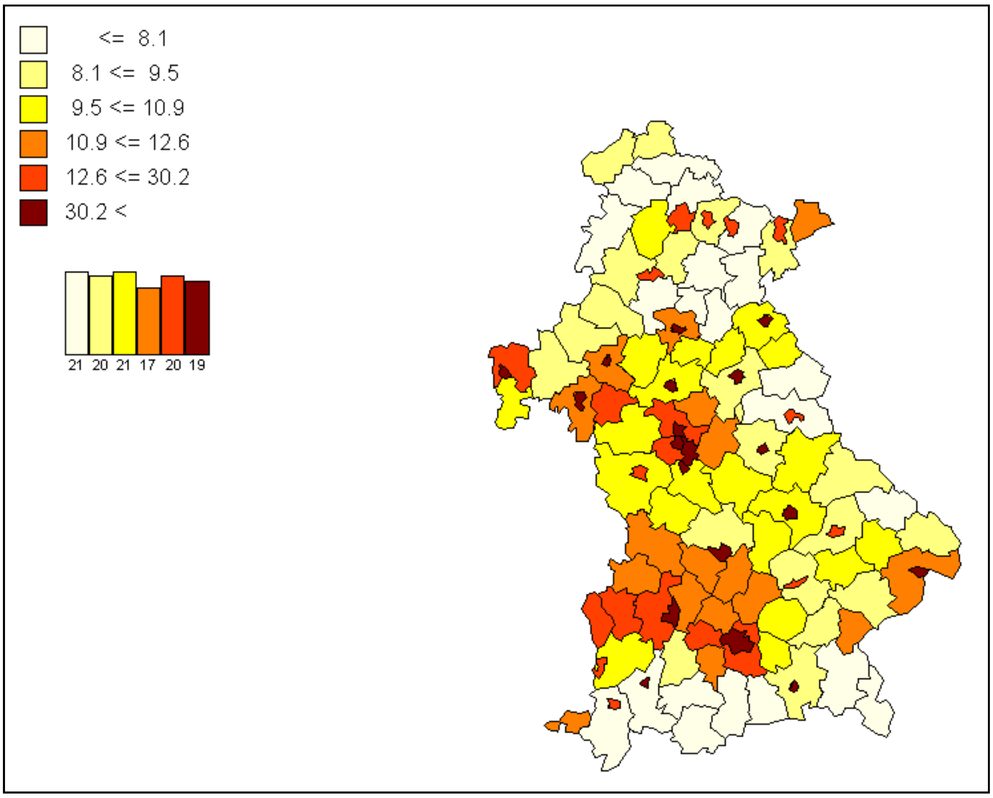

Figure 7: Distribution of settlement and traffic area as proportion of county size

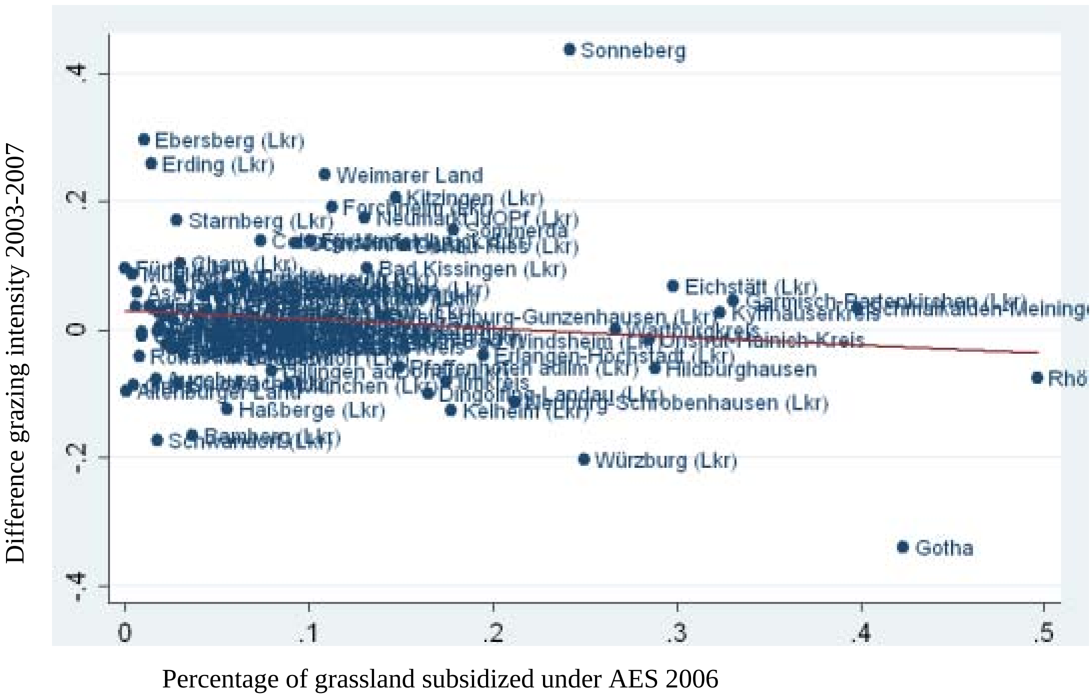

Figure 8: Scatter plot on difference in grazing intensity and AES