Cost-effectiveness of buying land for conservation versus paying land-users for conservation measures – the case of preserving an oligotrophic lake in a Natura 2000 area in North Germany

Schöttker, Oliver and Wätzold, Frank

Brandenburg University of Technology Cottbus - Senftenberg

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Oliver Schöttker, Chair of Environmental Economics,
Brandenburg University of Technology
Cottbus - Senftenberg
Erich-Weinert-Straße 1, Building 10, 03046 Cottbus
+49 (0)355 69 3096, oliver.schoettker@b-tu.de

Frank Wätzold, Chair of Environmental Economics,
Brandenburg University of Technology
Cottbus - Senftenberg
Erich-Weinert-Straße 1, Building 10, 03046 Cottbus
waetzold@b-tu.de

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Keywords

agri-environment scheme, biodiversity, conservation payments, grassland, make-or-buy decision, mode of governance, payments for ecosystem services, conservation costs

Abstract

Cost-effective implementation of measures to conserve biodiversity is often a major target of conservation organisations, and choosing the correct mode of governance can be important in this context. Nature conservation organisations can, in principle, choose between two distinct modes of governance to implement conservation activities: they can (1) buy desired areas of interest and implement conservation measures themselves (*buy option*), or (2) offer payments to landowners to incentivize them to voluntarily preserve or create habitat on their land (*compensation option*). In this paper we analyse the cost-effectiveness of these two modes of governance in a case study on a conservation project in a Natura 2000 area in Schleswig-Holstein, Germany. The actual costs of the *buying option* are compared with the potential costs of implementing the *compensation option*. We developed a costing framework to compare the costs of both options over time, given they generate the same ecological results on an identical project area. We find that the cost-effective solution depends, among other things, on the conservation timeframe considered and on cost components such as transaction costs, leasehold rent and land prices.

1 Introduction

Conservation funds are scarce. Conservation agencies therefore need to use their funds cost-effectively, i.e. they must select conservation options which maximise the achievement of their conservation goals with the financial resources available (Birner and Wittmer 2004; Wätzold and Schwerdtner 2005; Ferraro and Pattanayak 2006; Naidoo and Ricketts 2006). Suggestions for improving the cost-effectiveness of conservation policy instruments have hitherto focussed mainly on improving the spatial allocation of conservation measures. Examples of this type of research include Polasky et al. (2008), Van Teeffelen et al. (2012), and Duke et al. (2013), for conservation planning, and Armsworth et al. (2012), Wätzold and Drechsler (2014) and Wätzold et al. (2016), for conservation payments. Other research compared the cost-effectiveness of a proactive conservation policy with a policy that only sets in when a species is nearly extinct (Drechsler et al. 2011), the cost-effectiveness of integrating borrowing and budget carry-over in land acquisition strategies by conservation organisations (Lennox et al. 2017) and the participation of private versus public land owners in conservation contracts (Hily et al. 2015).

A hitherto neglected area of research to enhance the cost-effectiveness of conservation policy instruments is the choice of the relevant mode of governance for an area of conservation interest and of the management options implemented on that area (Juutinen et al. 2008; Muradian and Rival 2012; Schöttker et al. 2016). In this context it is important to ask whether it is more cost-effective for nature conservation agencies to (1) buy desired areas of interest and implement conservation measures themselves or through closely monitored firms (*buy option*), or (2) offer payments to landowners to incentivize them to voluntarily preserve or create habitat on their land (*compensation option*) (Curran et al. 2016; Schöttker et al. 2016).

This question is related to the "make-or-buy decision" originally investigated in the context of the theory of the firm and the field of transaction cost economics (Coase 1937; Williamson 1975). The general make-or-buy decision addresses the question of whether firms should produce some of their (intermediate) products themselves, i.e. internal provision, or instead purchase the same product from another company, i.e. external provision. In the context of nature conservation, internal provision can be seen as the management of nature conservation sites through nature conservation agencies on land that was originally bought by the agency and by measures performed by the agency itself or closely monitored by it. External provision on the other hand is equal to a provision of the same conservation outcome by the same conservation measures only performed by a firm or an individual outside the conservation agency but contracted and paid by the agency (compare Klein 2008). Research related to the make-or-buy decision in nature conservation is rare. Schöttker et al. (2016) apply an ecological-economic model to analyse how ecological and economic parameters of the decision problem influence the cost-effectiveness ranking of the two options. Juutinen et al. (2008) compare costs for forest conservation through conservation contracts and land purchase in Finland, and Curran et al. (2016) compare costs of hypothetical land purchase and costs of a payments for ecosystem services (PES) scheme for forest conservation in Central Kenya.

Here, we aim to contribute to this small but growing research area and present a further empirical study on the make-or-buy decision in nature conservation. We analyse the cost-effectiveness of the *buy option* compared with the *compensation option* for the conservation of an oligotrophic lake in a Natura 2000 area in Schleswig-Holstein, Germany. We calculate the actual costs incurred for buying land at the conservation site and managing it for the purpose of reducing nutrient input from the surrounding agricultural areas from 1980 until 2015. We then compare these costs with the hypothetical costs of compensating farmers for applying the same management which enables us to derive the cost-effective solution. Our study differs from those of Juutinen et al. (2008) and Curran et al. (2016) in several ways. We analyse conservation on agricultural land whereas they focus on forest conservation, this implies for example, that forest management leads to a more long-term costing framework, while our research considers a rather short-term costing framework. Moreover, we carry out an ex post analysis whereas their studies are of a prospective nature. This enables us to assess the impact of real world events on the cost-effectiveness of the two options such as the shift to the production of energy crops in Germany (Dauber et al. 2016).

2 *Materials and methods*

2.1 Case study description

2.1.1 Conservation problem

The conserved area around Lake Bültsee covers approximately 71 ha in the federal state of Schleswig-Holstein, Germany (Figure 1). It consists of the approximately 20 ha sized lake and a surrounding grassland area of approximately 51 ha (Kämmer 2002). The area is located about 35 km northwest of the federal state's capital, Kiel, and close to Eckernförde Bay. It was purchased gradually from 1980 to 2011 to establish a conservation site at and around the lake. Lake Bültsee and the surrounding littoral zone was declared a nature conservation site in 1982. It is embedded in the German Natura 2000 network "*Naturpark Schlei*" and the FFH area "*Großer Schnaaper See, Bültsee und anschließende Flächen*" (FFH DE 1524-391).

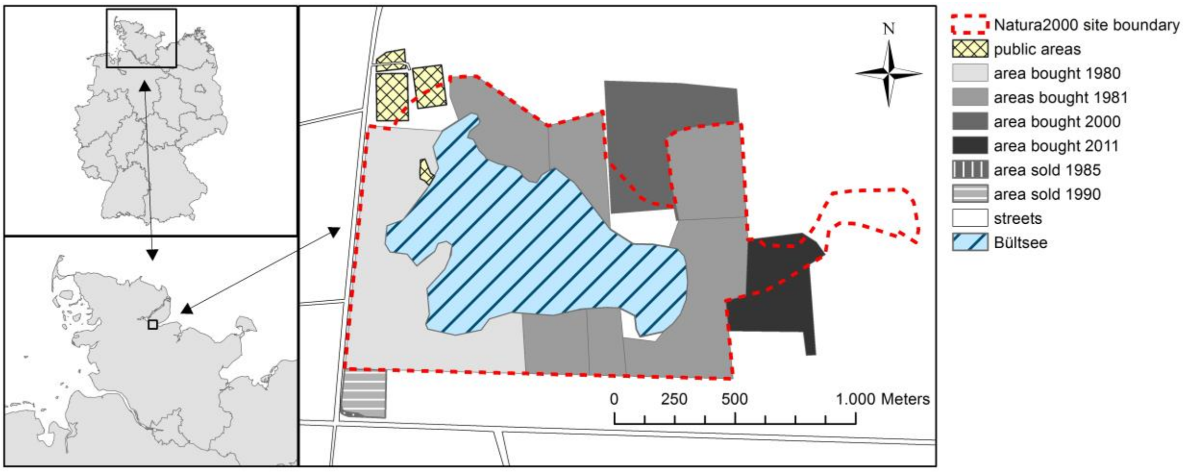

Figure 1: Lake Bültsee conservation area in Schleswig-Holstein, Germany, with its different terrain and grassland types (see online version for colour version). The map is based on ArcGIS map data Europe NUTS 1, management plan data for the FFH area "Großer Schnaaper See, Bültsee und anschließende Flächen", and data from SNSH.

Lake Bültsee is a kettle hole which was formed during the Weichselian glacial period as an oligotrophic, i.e. nutrient-poor, glacial lake. The surrounding area consists of sandy soils which strongly determine the nutritional supplement and supply of the lake. Past farming activities, especially intensive farming in the 20th century, led to a strong increase in the nutrient supply – i.e. the concentration of NOx and other fertilizer-induced nutrients. This transformed the lake from poor to medium nutrient levels (mesotrophic). The lake is surrounded by fields used for agriculture, which add a strong nutrient supply to the lake by surface water drainage and pollution of the groundwater by fertilizers.

The main conservation target is to re-establish an oligotrophic lake with a corresponding surrounding ecosystem of specially adapted fauna, e.g. the water lobelia (*Lobelia dortmanna*), quillworts (*Isoetes lacustris*) or the European shore-weed (*Littorella uniflora*) and a generally nutrient-poor regime of the surrounding dry grassland. The first two species are protected under the German Federal Nature Conservation Act (BNatSchG) as endangered native species, while the third species is not protected but considered endangered. Since 1996, an extensive cattle grazing regime is implemented on the area under conservation. A herd of Galloway cattle grazes on the grassland and littoral zone, thereby effectively reducing unwanted growth of vegetation around the lake and thus improving the growth of target species in the littoral zone through reduced nutrient intake into the lake. The cattle graze throughout the year, without being fed additionally and without additional external supply of fertilizers. In 1995, as an initial conservation measure, willow and alder trees were removed. In 1996, this was repeated and additionally, any excessive growth of vegetation along the southern shoreline was mowed or kept low with the help of sheep grazing to allow the target fauna to grow unimpeded. In 1996, the management of the littoral grassland was changed from extensive sheep grazing to extensive cattle grazing (Kämmer 2002).

2.1.2 Conservation actors

The conservation project is implemented by a government-funded but independent nature conservation foundation, *Stiftung Naturschutz Schleswig-Holstein* (SNSH), which buys and administratively manages land for nature conservation purposes in the federal state of Schleswig-Holstein, Germany. SNSH was founded in 1978 with the goal of managing areas used for agriculture or forestry in order to establish environmental or biodiversity protection. For this purpose, SNSH leases or buys areas at the public land-market. These areas are then withdrawn from their original use and transferred into (permanent) conservation sites. SNSH owns a total of over 35,000 ha in Schleswig-Holstein, of which our case study area, represents only a small, but one of the oldest fractions (Stiftung Naturschutz Schleswig Holstein 2015).

The extensive grazing management is operated by a contractor, *Bunde Wischen e.V.* (BW). BW is a registered association founded in 1986 in the context of a local project for orchid protection through the implementation of extensive grassland measures. BW manages over 700 ha of agricultural land in Schleswig-Holstein for the purpose of organic farming and nature conservation (Kämmer 2002). BW leased the land around Lake Bültsee from SNSH and implements the measures prescribed by SNSH. BW does not receive compensation payments from SNSH for implementing the prescribed measure, however it qualifies for AES funding for extensive grassland measures. BW keeps the economic profit generated on the area. Only in recent years, leasehold payments are paid from BW to SNSH.

2.2 Data Collection

Together with SNSH and BW, data were gathered on the actual costs and financial outlays regarding the purchase and management of the conservation area at Lake Bültsee conservation site. The data contains detailed information on buying costs and side costs, i.e. notary fees, taxes, and measurement costs, from 1980 to 2011. Third party data was used to estimate the costs of the hypothetical compensation option, i.e. the profitability of agricultural land under intensive and extensive management and the resulting compensation payment. A literature research revealed further data on transaction costs, land prices and interest and discount rate estimates. Some data gaps, especially in the profitability datasets, were filled using German consumer price index-based interpolation.

2.3 Costs of the buy option

2.3.1 Cost function

The total costs of the project from year t_{start} to a given end-year T, expressed in values of the year t_{start}, can be calculated with equations (1a) and (1b):

$$C_{t_{start}}^{buy} = \left(\sum_{t=t_{start}}^{T} d_t (p_t + \phi_t + m_t + a_t - l_t) \right) + (-v_T^{ext} + s_T) d_T \qquad (1a)$$

with

$$d_t = \begin{cases} 1 & for\ t = t_{start} \\ (1 + i_{t-1})^{-1}\, d_{t-1} & \forall\ 0 < t < T \end{cases} \qquad (1b)$$

where d_t is the discount factor for the year t, p_t the sum of the purchasing prices of all parcels of land bought, ϕ_t the side costs of purchasing the parcels, m_t the annual agricultural costs of managing the purchased parcels in a desired way, a_t the administrative management costs, l_t the leasehold income gathered from third party contractors, all in year t. The value of conserved land is v_T^{ext}, $s_T = \sum_{t=t_{start}}^{T} \phi_t d_t$ the side costs of selling the land, both in year T, and i_t the real market interest rate (based on the yield of German government bonds with longer than 4 years maturity).

We assume that the extensive grassland value v_T^{ext} is proportional to the intensive agricultural land value v_T^{int} (Ciaian et al. 2010; USDA 2015) and thus

$$v_T^{ext} = \theta\, v_T^{int}\ with\ \theta \leq 1. \quad (2)$$

To calculate the costs of the *buy option*, we subtract the value of the extensive grassland in year T from the cumulative costs of buying the land in the respective timeframe and add selling side costs s_T (see eq. (1a)). This step is necessary to establish comparability with the hypothetical compensation scheme in which land is reused for possible intensive agriculture after a conservation contract terminates.

2.3.2 Actual costs of land acquisition and management

The costs of land acquisition including side costs from 1980 until 2011 are provided in Table 1. The annual administrative costs of managing the conservation site are relatively small. Furthermore, they cannot be accounted for directly, as the relevant employees are responsible for multiple projects. SNSH estimates annual expenses for personnel of 970 € and travel costs of 72 €.

	buying costs	side costs	area in ha
1980	207,073.21 €	56,313.56 €	17.6
1981	229,600.22 €	49,872.53 €	23.7
1985	-1,238.93 €	8,028.20 €	-0.05
1990	9,513.61 €	1,520.42 €	-1.2
2000	68,001.82 €	8,590.70 €	6.3
2011	83,101.30 €	19,042.25 €	4.3
	596,051.23 €	***143,364.66 €***	
	739,415.89 €		**50.65 ha**

Table 1: Buying costs and side costs of the implementation of Lake Bültsee conservation project (Euro values are given in nominal terms). In 1985, a marginal section of the conservation area was ceded for the implementation of an infrastructure project, resulting in a decrease in area, with the mentioned sale revenues and side costs. In 1990, parts of Lake Bültsee conservation area were sold, while in return a different conservation area was extended. This exchange resulted in the given positive buying and side costs.

By giving the area as a leasehold to a third party contractor, SNSH was able to generate a leasehold income. From 1980 to 2008 the annual rent was zero, as it was considered that a rent would make the extensive management of the area unprofitable (cp. Mewes et al. (2015) for costs of extensive grassland management). From 2009 onwards a rent of 40 € per ha and year was charged (Table 2).

	administrative costs	leasehold rent	
	per year	total	per ha
1980-2008	1.042,00 €	0 €	0 €
2009-2010	1.042,00 €	1.853,39 €	40,00 €
2011-2015	1.042,00 €	2.025,71 €	40,00 €

Table 2: Development of the annual management costs and rental income over time.

From 1980 to 2015, the price of agricultural land has fluctuated strongly not only in Schleswig-Holstein but all over Germany. While in 1980 one hectare of agricultural land in the study region cost 14,240 €, the price dropped to 7,770 € in 1993 (Statistikamt Nord 2015). Since 2006, a sharp increase in prices for agricultural land in Schleswig-Holstein can be observed which is due in particular to the increasing cultivation of energy crops such as maize (Lupp et al. 2014; Dauber et al. 2016). This has resulted in an increase in prices for agricultural land to 27,500 € per hectare in 2015.

Based on the average agricultural land prices in Schleswig-Holstein, we estimate the land value of the conservation site around Lake Bültsee for each year. We assume that the land can be sold and reused for agricultural purposes to recoup the initial monetary outlay.[1]

Following equation (1a), the resulting overall costs of the *buy option* are calculated by summing up the discounted buying and side costs for the individual purchasing transactions and subtracting the discounted leasehold income and the discounted value of acquired land. The values are calculated for each year during the case study timeframe and discounted from the respective year to the base year 1980. This allows us to evaluate the costs of the project from the beginning up to each year during that timeframe retrospectively.

[1] Federal and European law, however, regulate withdrawal of land from extensive land use and consequential re-intensification (e.g. DGLG of 2013 in Schleswig-Holstein). Additionally, SNSH does not plan to sell or re-intensify any of the area around Lake Bültsee. See section 4 for a discussion of the influence of greening regulations.

2.4 Costs of the compensation option

2.4.1 Cost function

The costs of buying relevant agricultural area and managing it internally are to be compared with the hypothetical costs of implementing a compensation scheme with an identical conservation outcome. We assume that a certain conservation target can be achieved through identical conservation measures independently of the mode of governance, in turn causing only different cost patterns (cp. Muradian and Rival 2012 and Schöttker et al. 2016). Furthermore, we assume that each landowner is, in principle, willing to participate in a scheme, if offered a compensation payment which at least covers the costs of participation, i.e. the foregone profit due to extensive management as prescribed by the scheme plus additional transaction costs due to participation and implementation (Defrancesco et al. 2008; Franzén et al. 2016; Greiner 2016). For simplicity, we ignore the possibility of landowners to use the bargaining power they obtain if their participation is crucial for the success of the conservation measure (cp. Discussion). In addition to the costs for compensation, the agency faces a certain amount of transaction costs including personnel expenses, travel expenses, and monitoring and enforcement costs (McCann 2013).

The total costs for the hypothetical compensation scheme from year t_{start} to a given end-year T, expressed in values of the year t_{start}, can thus be calculated with equation (3) with f_t the area in hectares receiving compensation, $\overline{cp_t}$ the homogeneous compensation payment, and t_t^{agency} the transaction costs borne by the agency, all in year t.

$$C_{t_{start}}^{borrow} = \sum_{t=t_{start}}^{T} d_t \, f_t \, \overline{cp_t} \, (1 + t_t^{agency}) \tag{3}$$

The compensation payment $\overline{cp_t}$ paid in the scheme is determined with equation (4) where π_t^{int} is the potential profit per hectare agricultural land under intensive management, π_t^{ext} the hypothetical profit with (the prescribed) extensive grassland management, and t_t^{farmer} the transaction costs borne by the farmer for participating in the scheme.

$$\overline{cp_t} = \left(\pi_t^{int} - \pi_t^{ext}\right)\left(1 + t_t^{farmer}\right). \tag{4}$$

According to Falconer (2000) and McCann (2013) the agency level transaction costs as well as the farm level transaction costs are measured as a proportion of the compensation payment $\overline{cp_t}$.

2.4.2 Hypothetical costs of compensating farmers for conservation

For the profit maximising intensive land use we assume that land in the conservation area around Lake Bültsee is cultivated with the average land use pattern for crop production in Schleswig-Holstein. Thus, we assume the land is cultivated with a mixture of field crops according to the four most common field crops grown in Schleswig-Holstein – i.e. wheat, barley, maize and rapeseed – during the study case timeframe. According to our interviews we assume that from 2009 onwards the crop cultivation pattern transitions towards the more common and more profitable maize production. This is at least true in the study area, where most of the agricultural fields, and especially the fields surrounding the conservation area are cultivated with maize as an energy crop. Thus, from 2009 to 2015 maize is assumed to be the sole crop cultivated in the conservation area under profit-maximising land use. From 2006 to 2008 we assume a transition period in which the share of maize cultivation increases and the shares of the other three crops decrease.

Based on data on yield per hectare, crop prices and cultivation costs (Ruhr-Stickstoff Aktiengesellschaft 1974; Ruhr-Stickstoff Aktiengesellschaft 1988; Hydro Agri Dülmen GmbH 1993; KTBL 2005; KTBL 2009; KTBL 2014) we estimate the average profit and cost from intensive agriculture with the corresponding field crops.

We estimate for the potential profit in the hypothetical compensation scheme a revenue between 90 € and 160 € from the sale of cattle and/or dairy products per ha extensive grassland, costs of between around 310 € to 500 € per ha, and a total profit per hectare in the range from -200 € to -340 €. Our calculations show that over time, the corresponding profitability of extensive grassland measures varies but is negative throughout the whole study case timeframe, meaning that extensive grassland measures are, from the farmer's perspective, not economically attractive and need subsidies (cp. Mewes et al. 2015).

Additional to production and management costs, transaction costs contribute a substantial share to the overall cost of the *compensation option*. We take average values based on literature (Falconer 2000; McCann 2013), and assume that the farmers' transaction costs amount for 10% of the actual compensation payment, and the agencies transaction costs contribute 15% of the compensation payment.

2.5 Baseline scenario and sensitivity analysis

To analyse the costs of the case study we define a baseline scenario with a combination of average cost parameters. We then modify each parameter individually to assess possible causes for payment changes and show the management alternatives sensitivity towards parameter variation. This is done by creating high and low values for the parameters of transaction costs, leasehold payments and land value factor θ (Table 3 and section 3). To analyse the impact of the unprecedented increase in land prices on the cost-effectiveness of the two options – driven by the increase in energy crop production in the study region since 2006 – we estimate the hypothetical outcome of the management options with and without this boom in the energy crop sector.

sensitivity analysis	parameter	description	low scenario value	baseline scenario value	high scenario value
1	transaction costs farmers		0.05	0.1	0.15
	transaction costs agency	*as a fraction of the offered compensation payment*	0.1	0.15	0.2
2	leasehold payment		0 € per hectare and year	0 € per hectare and year from 1980 to 2008, and 40 € per hectare and year from 2009 to 2015	average leasehold payment for agricultural land in Schleswig-Holstein
3	land value factor θ	*grassland/ intensive cropland price ratio*	0.4	0.7	1.0
4	energy crop boom	*assuming, the development of energy crop sector expansion did not happen*		transition in cultivated crops from crop mix to full maize cultivation	no transition in cultivated crops to full maize cultivation; average, federal state level cultivation pattern

Table 3: Parameter values for different sensitivity analyses, with corresponding low, baseline and high scenario values.

Sensitivity analysis 1 considers variations of the baseline scenario value for transaction costs. The transaction costs are included into our calculations in equations (3) and (4), either being borne by the farmer or the agency. Literature suggests that overall transaction costs for agri-environment schemes vary between 14% and 40% of the compensation payment (Falconer 2000; McCann and Easter 2000; Kersten 2008; Thomas et al. 2009; McCann 2013). We thus assume low and high values in this range and individually vary farmer's and agency's transaction costs to 0.05 above and below the baseline scenario values of 0.1 for the farmers and 0.15 for the agency.

The actual leasehold rent that BW pays to SNSH is only a small fraction of what is paid on average for agricultural land or even extensive grassland in Schleswig-Holstein. We therefore also calculate the sensitivity of our results to changes in the leasehold rent which is considered in eq. (1a). For the low value we assume zero rent to be paid as was the case prior to 2008, while the high value is assumed to be the average values for leasehold rents in Schleswig-Holstein.

We assume that the value of extensive grassland is proportional to the value of intensive agricultural land (see eq. (2)). Ciaian et al. (2010) suggest for this proportion a value of $\theta = 0.7$ in Central Europe. We take this as the value for the baseline scenario case and vary it to 0.4 and 1.0 in sensitivity analysis 3 as estimates for weaker and stronger proportional relations. This is equivalent for SNSH being able to sell the extensive grassland either to the full market price for intensive agricultural land ($\theta = 1.0$), or to a reduced price ($\theta = 0.4$) (cf. eq. 2).

In our baseline scenario the expansion of the energy crop sector with resulting increases in agricultural land prices and product prices is considered. Since 2006, land prices in Schleswig-Holstein have more than tripled and income from intensive agricultural land use has risen steeply as well. As this development could not have been anticipated when the conservation project was initially set up in 1980, we analyse the sensitivity towards ignoring the effects of the energy crop boom and thus keep land prices and product prices fixed after the year 2006. As a result, we get a comparison between the actual development and a potential uninfluenced economic situation. As this is highly speculative, we do not implement any further price adaptation (e.g. due to inflation) and thus leave all cost parameters except product, land prices and leasehold rents unchanged.

3 Results

3.1 Results of the baseline scenario

We find, for the baseline scenario, that between 1980 and 2004, the costs of the *buy option* exceeded the potential costs of the *compensation option* (Figure 2), whereas from 2004 onwards the costs of the *compensation option* were higher than the costs of the *buy option*. This result can be easily explained, as for long-term investments one-time transaction costs (e.g. side costs) are lower on a per annum basis than for short-term projects. In the short-run, high one-time transaction costs make the *buy option* relatively unattractive. In the case study, this result is additionally driven by the development of agricultural land prices, which decreased significantly between 1980 and 1993 and thus would have caused high losses, if land had been sold during or shortly after this period.

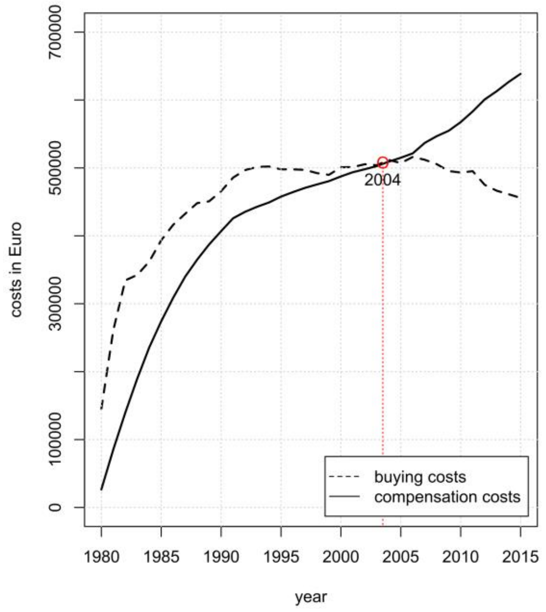

Figure 2: Cumulative discounted costs of the *buy option* (straight line) and the *compensation option* (dashed line) for the baseline scenario value between 1980 and 2015. The values are discounted to the base year 1980.

3.2 Sensitivity analysis

3.2.1 Transaction costs

The sensitivity analysis for the transaction costs results in a cost range of the *compensation option*. This is caused by a change in transaction costs borne by the conservation agency and compensation payments which include compensation for transaction costs of the farmer (see eqs. (3) and (4)). Although transaction costs make up only a small fraction of the total costs of the *compensation option*, changes in those costs have a substantial impact on predating (from 2004 to 1995) or postponing (from 2004 to 2008) the point where the *buy option* becomes more cost-effective than the *compensation option*, henceforth referred to as critical point.

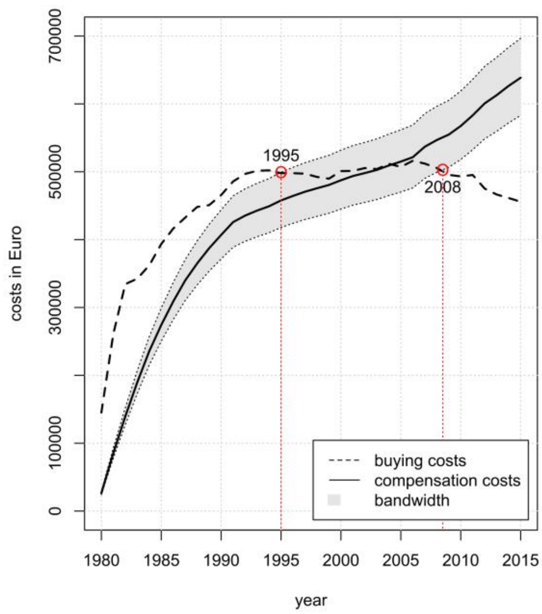

Figure 3: Costs of the *buy option* (dashed line), and *compensation option* (straight line) with the corresponding bandwidth for compensation costs (grey shaded area) due to variations in transaction costs (high value is at the upper edge; low value is at the lower edge of the shaded area). The values are discounted to the base year 1980.

3.2.2 Leasehold rent

Unsurprisingly, if we assume high values for leasehold rent, the *buy option* gets more attractive as the agency can generate higher income from giving the land as a leasehold to a contractor. Consequently, the timeframe in which the *compensation option* outperforms the *buy option* is shortened, shifting the critical point forward to the year 1993 (Figure 4). The low value scenario with no leasehold payment has hardly any effect. Differences in the baseline scenario only start in 2008 and due to the small differences between the two scenarios the advantage of the *buy option* is only marginally reduced between 2009 and 2015 compared to the baseline scenario.

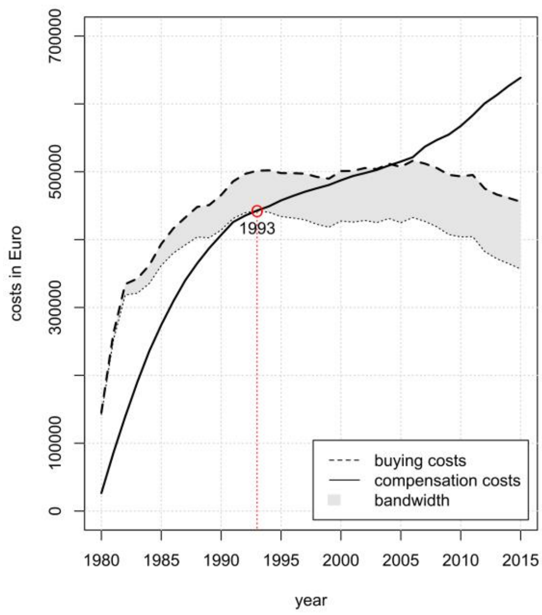

Figure 4: Costs of the *buy option* (dashed line), and *compensation option* (straight line) with the corresponding bandwidth for buying costs (grey shaded area) due to variations in the leasehold rent (high value is at the lower edge; low value is barely visible as it is very close to the actual, already very low lease hold rents). The values are discounted to the base year 1980.

3.2.3 Land value factor

Over the whole project timeframe, the land value varies significantly (Figure 5). This variation is amplified in the high value case and dampened in the low value case. It shows that with a decreasing value of θ the costs for the *buy option* rise (upper bound of the grey shaded area) as the land value decreases and thus can only be sold at a low price at the end of the conservation project (see eq. (1)). Hence, the critical point is postponed to the year 2007. For increasing values of θ, which implies an increase in the land value und thus a decrease in the costs of the *buy option*, this critical point is already reached in 1996 (see lower bound of the grey shaded area). Beyond that, in the preceding project run time between 1980 and 1996, the difference between both options is marginal with higher levels of θ. For sufficiently high values of θ, the *buy option* would always be preferable over the *compensation option*. However, even higher values of $\theta = 1$ are less reasonable, as they would represent a situation in which formerly extensive grassland could be sold for higher prices as intensive agriculture land, thus being essentially overvalued.

Rising land prices explain the growing advantage of the *buy option* over the *compensation option* in the last years of the project (since 2004). However, it is more likely that θ is in the range of 0.4 to 0.7 thus resulting in postponement of the critical point.

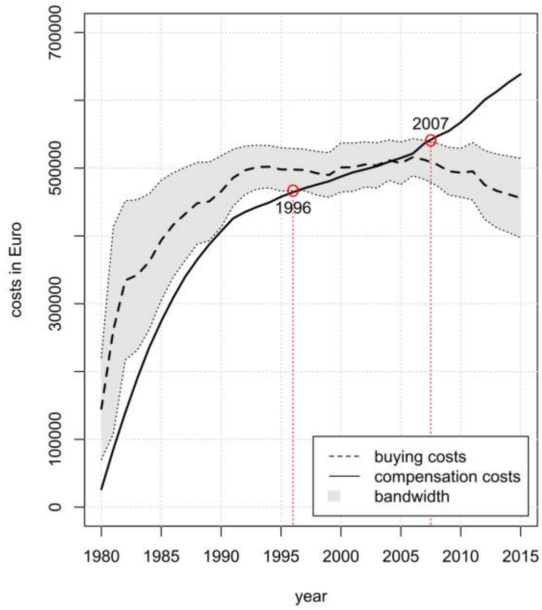

Figure 5: Costs of the *buy option* (dashed line), and *compensation option* (straight line) with the corresponding bandwidth for buying costs (grey shaded area) due to variations in the land value factor θ (high value is at the lower edge; low value is at the upper edge of the shaded area). The values are discounted to the base year 1980.

3.2.4 No energy crop boom

Figure 6 shows that under the assumption that an energy crop boom did not occur and, as a result, land and product prices have been more stable in the study area since 2006 (the start of the energy crop boom), the cost-effectiveness advantage of the *buy option* compared to the *compensation option* is strongly reduced in comparison to the baseline scenario. This is plausible under this scenario, because land prices do not rise as strongly as in the baseline scenario which reduces the potential revenue from selling land at the end of the conservation project. This in turn increases the overall costs of the *buy option*. A further effect in this sensitivity analysis is that the potential revenue from extensive and intensive agricultural measures is reduced by lower agricultural product prices (see eq. (1a)). This causes a reduction in the costs of the *compensation option* as compensation payments decrease (see eq. (4)). If agricultural product prices fall, intensive agriculture is less profitable, hence the opportunity costs of an extensive management scheme decrease, causing the compensation payments to decrease as well. Consequentially, both cost developments are closer to each other from 2006 onwards indicating a decreased superiority of the *buy option*.

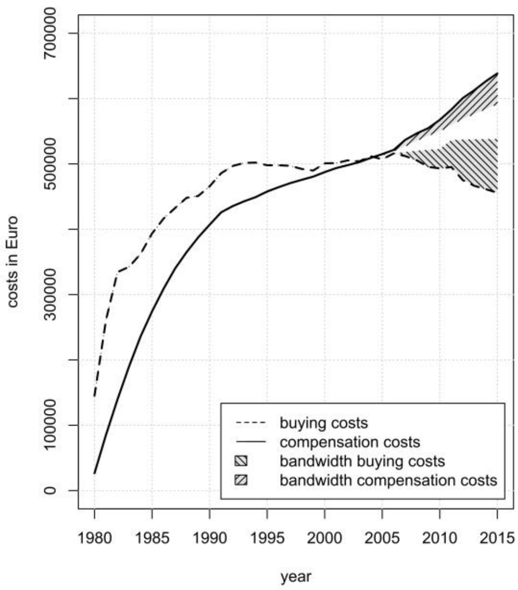

Figure 6: Costs of the *buy option* (dashed line) and *compensation option* (straight line) with the corresponding bandwidths (grey shaded areas) due to a hypothetically non-existing energy crop boom and thus decreased land and produce prices. The values are discounted to the base year 1980.

4 Summary and Discussion

Our research objective was to assess the cost-effectiveness of two modes of governance for an area of conservation interest and the resulting management options implemented on this area for a case study. We considered as modes of governance that (1) a conservation agency buys desired areas of interest and implements conservation measures itself or through closely monitored firms (*buy option*), and (2) an agency offers payments to landowners to incentivise them to voluntarily preserve or create habitat on the areas of interest (*compensation option*). Our case study looks at the implementation of extensive grassland measures around the oligotrophic Lake Bültsee in a Natura 2000 area in Northern Germany from 1980 to 2015 aimed at reducing the nutrient inflow from the surrounding agricultural areas. We find that the *buy option* outperforms the *compensation option* in the long run from 2004 onwards. In the short run however, the *compensation option* is the superior mode of governance. This result is driven by the fact that the one-time costs of buying land, i.e. the buying and selling side costs, dominate the cost structure in the short run and obviously can only be offset after a significantly long project runtime. Land price fluctuations were a further key factor. Extensive parts of the conserved area were bought at relatively high prices in the 1980s, while prices dropped steeply in the 1990s. This implies that the low prices in the 1990s had a negative effect on the cost-effectiveness performance of the *buy option* in comparison to the *compensation option*. This trend, however, was reversed after land prices increased substantially from 2006 onwards.

We made a few assumptions in our case study that require discussion. First, we assumed that the mode of governance in practice does not change the possible conservation results. We assume that, ceteris paribus, the different modes of governance only result in different cost structures and thus total project costs, while still being able to result in the same ecological outcome. This assumption is necessary to allow a proper comparison between the two alternative governance choices in terms of their cost-effectiveness. Whether this assumption holds in reality is however an open question. Conservation organisations that buy land tend to keep and manage their properties for long time periods, and thus have a corresponding planning horizon for their conservation targets and the resulting implementation of measures (Theobald et al. 2000; Groves et al. 2002). Compensation-based projects, on the other hand, require more flexibility as potential participants can decide on a short-term basis whether to participate in a programme or not. Moreover, conservation funding, if spent annually, is more easily cut if the political or economic circumstances become less favourable for biodiversity conservation. This leads to a different planning horizon and may consequently result in different conservation targets and measures for such projects with different ecological outcomes.

We assumed further that the landowners are willing to participate in conservation measures with certainty, if it is profit-maximising for them. We made this assumption to ensure that the intended conservation target can be reached. However, this might be different in reality. The willingness to participate in nature conservation schemes depends, among other factors, on former experience with conservation projects, programme objectives, and environmental attitude, but also on participants' expectations of potentially permanent changes in the usability of their land due to implementation of measures (Millennium Ecosystem Assessment 2005; Moon and Cocklin 2011; Yeboah et al. 2015; Unay Gailhard and Bojnec 2015; Greiner 2016) and certainly varies between conservation projects, timing and location (Vanslembrouck et al. 2002). Therefore, land owners on potential conservation areas might not at all or only temporarily be willing to participate in a compensation scheme with resulting negative ecological impacts (Van Teeffelen et al. 2012; Schöttker et al. 2016).

A somewhat different but related case arises if land owners are, in principle, willing to participate in a conservation project, and realise that their land is crucial for the realisation of the project. In this case farmers may act strategically and try to capture so-called information rents (Ferraro 2008) by overstating the opportunity costs of participation and requesting higher compensation payments or purchasing prices for their land (Prazan and Theesfeld 2014; Daniele et al. 2015; Banerjee et al. 2016; Kuhfuss et al. 2016). To what extent this farmer-side strategic behaviour is prevalent in the study area and to what extent it can be counteracted by agency-side behaviour such as risk reduction through trust-building remains an open question.

German and European legislation allows intensification of extensively used grassland only under certain conditions (referred to as greening), e.g. the provision of appropriate compensation areas (see DGLG 2013 for Schleswig-Holstein). A complete intensification prohibition is only in place in Natura 2000 and FFH-areas, both of which apply to the Bültsee area. Therefore, our assumption that the area used in the project can easily be sold and used intensively only reflects the real life situation to a limited extent. However, according to its bylaws, SNSH is, in principle, allowed to sell every part of its conservation areas if compensation areas are developed in return. If, therefore, it were necessary or opportune to sell the land at Lake Bültsee for ecological, environmental or economic reasons, this would be possible as long as compensation areas are provided. Against this background, a re-intensification of the project area is at least difficult under existing law, however a potential sale is possible. This obviously might lead to reduced land prices. We account for this in our analysis by introducing the land value factor $\theta = 0.7$ for the case study calculations, representing the price ratio of extensive and intensive agricultural land prices.

When selecting between the *buy option* and the *compensation option* in the real world, aspects other than those considered in this paper play a role as well. For example, monitoring and enforcement of compliance with the prescribed conservation measure seem to be easier in the *buy option*. There is no need for compliance monitoring if the conservation agency carries out the conservation activities by itself and it seems rather easy if the agency selects a firm with an intrinsic interest in conservation, as with *Bunde Wischen e.V.* in our case study. In contrast, if landowners without an intrinsic motivation carry out the conservation measures, the importance and hence the costs of monitoring and enforcement measures increases (Wätzold and Schwerdtner 2005). Another relevant aspect is the land owners' acceptance of the two options. German farmers seem to have a strong preference for the *compensation option* as selling the land to a conservation agency implies that it is taken away "irreversibly" from agricultural use (Beer 2016).

Generalising insights from a case study is always only possible to a limited extent, and the assessment of the cost-effective mode of governance of conservation projects comparable to our case study is an empirical issue and requires a detailed examination of the specific economic and ecological conditions of the case study. However, we are able to identify a few patterns that allow some careful generalisations. One-time transaction costs of land purchase and sale are high which suggests that – ceteris paribus – the cost-effectiveness of the *buy option* increases in comparison to the *compensation option* with the planned duration of the conservation project. Note that although, in principle, long-term conservation is desired from an ecological perspective, conservation takes place in a dynamic world where aspects such as climate change and changing socio-economic conditions may call for a re-allocation of conservation areas (Van Teeffelen et al. 2012; Van Teeffelen et al. 2014) implying the need to sell conserved land. Our case study also draws attention to the general importance of changes in land prices (cp. Carwardine et al. (2010) as an example of research on future cost uncertainty) and their impact on the cost-effectiveness comparison of the *buy option* and the *compensation option*. The drop in agricultural land prices in the 1990s substantially extended the cost-effectiveness advantage of the *compensation option* in those years and if the increase in land price due to the boom in energy crops had not occurred, the cost-effectiveness advantage of the *buy option* from 2004 onwards would have been much smaller.

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