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Towards an agri-environment index for biodiversity conservation payment schemes

by
Franziska Dittmer and Markus Groth

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Towards an agri-environment index for biodiversity conservation payment schemes

Franziska Dittmer, Markus Groth[1]

Summary

The aim of the paper is to give suggestions about how an agri-environment index can be designed by taking into account specific ecological and economical factors that reflect benefits and costs of biodiversity conservation. Main findings are that the general structure of an agri-environment index is recommended to be a benefits-to-cost ratio, whereby the conservation benefits are accounted for by the following factors which evaluate i) certain criteria that value the ecological quality of a site and point out its significance for biodiversity conservation (Conservation Significance Factor), ii) a criterion that reflects the connectivity of the site which is an important factor for species migration (Connectivity Factor) and iii) criteria that estimate the potential biodiversity outcomes induced by specific management actions (Conservation Management Factor). The Cost Factor reflects the amount of money that the landholder demands as compensation payment for his conservation services. The paper points out that an agri-environment index is a promising approach to encourage and compensate farmers for biodiversity-friendly management actions. Thereby, an improvement of the effectiveness and efficiency of European conservation payment schemes is a decisive contribution to biodiversity conservation in agricultural landscapes.

Key words: agri-environmental policy, biodiversity benefits index, biodiversity conservation, ecosystem services, environmental benefits index, rural development

1. Introduction

The United Nations proclaimed 2010 to be the International Year of Biodiversity. Europe's biodiversity currently faces a rapid loss within agricultural landscapes, which implies a decline of various ecosystem services that are of socio-economic value. Against this background, increasing attention is to be paid to farming practices that contribute to the maintenance and enhancement of biodiversity and ecosystem services. Therefore, the development of conservation payment schemes that take account for the costs and benefits of biodiversity conservation management actions is a major challenge for present European agri-environmental policy.

[1] Corresponding author. Leuphana University of Lueneburg, Sustainability Economics Group, Scharnhorststr. 1, D-21335 Lueneburg, Email.: groth@uni-lueneburg.de.

Agri-environment schemes (AES) that aim to conserve biodiversity on agricultural lands beyond mandatory standards for agricultural practice (EAFRD REGULATION, article 39(2), (3)), are the most important European policy instrument to conserve biodiversity on private lands. A main issue of biodiversity conservation payment schemes in general – and of AES in particular – is the allocation of limited financial resources for a maximum level of biodiversity conservation. Thus, a central point of conservation schemes is to achieve budgetary cost-effectiveness – which means maximizing environmental gain (or in this case maximizing biodiversity conservation) given an available budget (CATTANEO ET AL. 2005; CLAASSEN ET AL. 2008). The challenge of such payment schemes is to choose those landowners out of a list of applicants who can provide biodiversity conservation most comprehensively and at the lowest costs. A promising approach to evaluate and compare applications according to specific criteria in order to target investments for maximizing the gain in conserving biodiversity seems to be the development and application of an agri-environment index (AEI).

An AEI can be defined as "a set of measurable indicators that are combined to quantify the benefits of investing in a given location, project, or region. The AEI is a numéraire (unit of value) that provides a relative […] measure of benefit arising from one investment option (e.g., farm, site, project, region) compared to another." (HAJKOWICZ ET AL. 2009: 221). Depending on the design of the conservation payment scheme, the AEI can also contain – besides the measurement of benefits – a cost factor. This factor can for instance evaluate the monetary costs of a given project and enables a cost-benefit equation of different investment options.

Accordingly, the leading question of this paper is how an AEI can be designed to quantify the biodiversity conservation benefits and costs of a given investment option within a biodiversity conservation payment scheme. In order to specify suggestions for the design of an AEI, the focus will lie on biodiversity conservation in grasslands. This specific habitat type is chosen for two main reasons. Grasslands are among the most biodiversity rich habitat types in Europe (EC 2008) and the area of grasslands declines steadily (EC 2008; BFN 2009). Moreover, the conservation and recreation of semi-natural habitats (like grasslands) via the use of government incentives is politically intended, like for example by the German 'National Strategy on Biological Diversity' (BMU 2007).

Within the paper, two different environmental indices are used as role models: the Environmental Benefits Index (EBI) and the Biodiversity Benefits Index (BBI). These specific indices are chosen, because they are successfully approved in conservation payment schemes in the USA and Australia, and can provide relevant information for designing an AEI, although they do not particularly concentrate on biodiversity conservation in grassland habitats. Based on former experiences, suggestions will be discussed, what specific factors an AEI may contain to quantify the prospective biodiversity conservation benefits and – depending on the scheme configuration – how a cost factor may be implemented into an AEI. Finally, an AEI will be developed on the basis of the discussed factors and limitations.

2. The Environmental Benefits Index (EBI)

The US Conservation Reserve Program (CRP) is a voluntary conservation payment scheme that was originally established under the Food Security Act in 1985 to offer annual payments to private landholders for reducing soil erosion on highly erodible cropland. With the years the aim of the programme expanded to protecting or enhancing environmentally sensitive cropland and pasture (USDA 2007).

As part of the general sign-up, landowners with eligible land compete in a national procurement auction for acceptance. The bids are offered during specified enrolment periods and state what land will be enrolled, what land cover would be established and the desired payment (bid price). Then each eligible bid is ranked in comparison to all other bids on the basis of the so called Environmental Benefits Index (EBI). All bids with EBI-scores above a certain cut-off level (that is determined for each period after the bids are received) are accepted. The bid price – that has to be below a soil-specific maximum bid cap – is taken account of in the EBI, whereby the EBI increases if the bid price per acre is relatively low (USDA 2007; CLAASSEN ET AL. 2008).

The EBI is used since 1990 (starting with sign-up 10) in order to rank bids according to a broader set of environmental objectives and the costs of the contract (bid price per acre). Since then, the practice of accepting all bids, that where under a pre-defined bid limit, ended and only a proportion of proposed CRP contracts have been accepted in a given sign-up period (SMITH 2003; USDA 2007; CLAASSEN ET AL. 2008). The EBI currently contains six main factors (N1-N6) to assess the estimated environmental benefits for the land offered and the bid price. The EBI score of an offer (*i*) will be accounted as: $N1_i + N2_i + N3_i + N4_i + N5_i + N6_i$ .The six main factors contain sub factors that can reach a certain points score and are added up to determine the points score of the main factor (e.g. N1=N1a+N1b+N1c). All factors and sub factors as well as the weights (the maximum achievable score for each factor and sub-factor) are determined before the beginning of each sign-up period and can vary in composition and weighting from period to period (USDA 1999; USDA 2006; USDA 2007).

All in all, the EBI contains three major (wildlife habitat, water quality and soil erodibility) and two minor environmental benefits factors (enduring benefits and air quality) where totally 395 environmental points can be achieved. The cost factor (N6) is included in the EBI since the 13th sign-up period. Before that, offers were ranked according to the ratio of the EBI as part of the contract costs.

Since its application the EBI has been used to allocate US$ 29 billion (HAJKOWICZ ET AL. 2009). Thereby it is to be mentioned positively, that the cost-benefit targeting of the EBI is suggested to induce environmental cost-effectiveness. Moreover, the EBI substantially increased environmental benefits of the CRP (CLAASSEN ET AL. 2008).

Beside these positive aspects, there are critics about the EBI design. The first critical issue is that the individual main factors of the EBI are additive. This means that a poor performance in one indicator can be easily compensated by a strong performance of another. The second criticism is that the cost factor is one of the weighted indicators within the EBI. This implies that the bid requires a minimum environmental score to be accepted, which means that restoration activities with smaller environmental benefits and higher input cost in the beginning are presumably disadvantaged compared with other conservation activities. Moreover, the costs – that account for approx. 27.5% of the EBI – are not directly compared with the benefits and therefore do not correctly provide an objective cost-benefit-measure for the sites.

3. The Biodiversity Benefits Index (BBI)

The BBI was first adopted in the Australian BushTender trial[2], which is a voluntary auction-based program designed to help improve management and protection of native vegetation for biodiversity on private land (DSE 2009a). Unlike the US-American CRP, the Australian BushTender trial has one single objective – the conservation of remaining native vegetation and thus the protection of native species, which are to a large extend threatened and endangered.[3] The programme uses the approach of conservation procurement auctions, with discriminatory payments, in which landholders competitively bid for contracts to undertake specified management actions[4] (DSE 2008a; DSE 2008b). The first trial was held in 2001/2002 in two different regions of Victoria (DSE 2008d).

[2] BushTender is a registered trademark of the State of Victoria (Department of Sustainability and Environment).

[3] In Victoria 12% of the remaining native vegetation is on private land and occupies 30% of Victoria´s threatened species. Moreover 60% of the native vegetation on private land is a threatened vegetation type (which means that its conservation status is endangered, vulnerable or depleted) (DSE 2008b).

[4] Common conservation actions encompass: "fencing to control grazing by stock; excluding stock or adopting grazing practices to maximize vegetation quality; weed and pest animal control above current responsibilities ; retaining trees, native

The BBI recognizes for each individual bid, the range of biodiversity values across the landscape, the diversity of landholder's conservation actions and the range of outcomes generated by these (DSE 2008a). Therefore the BBI contains one indirect element – the 'Current Site Quality' upon which further calculations are based – and three direct elements: the 'Biodiversity Significance Score (BSS)', the 'Habitat Services Score (HSS)' and the 'Cost' factor. The product of the BSS and HSS depict together the relative benefits of the respective site. The cost factor contains the full landowners costs of management actions, which are submitted in the bid price ($ of landholders bid). The BBI is the result of the benefits-to-cost ratio.

Within the first two trials, the BBI was used to allocate a sum of A$1,200,000 for the protection of around 4800 ha (DSE 2008a). The fact that 84-94% of the landholders made satisfactory progress and the level of compliance rates increased with each year participating in the trial, shows that the biodiversity benefits substantially increased due to the BushTender trial. Moreover, a gain of totally 653 habitat hectares as well as an enhancement of the quality of 1,785 ha of 39 rare and threatened EVCs has been achieved in the two trials.

Overall there are several advantages of the BBI structure. The first positive feature of the BBI is that the bids are evaluated after the 'best value for money' principle. This means that bids with high biodiversity benefits (numerator) and low costs (denominator) get a high BBI result and thus a high rank in the selection procedure. The Tender Evaluation Panel determines the cut-off point (the point that divides successful from unsuccessful bidders) by considering the available marginal cost curve. Secondly, and in comparison to the EBI, it should be pointed out that the BBI accounts the biodiversity benefits in a hybrid functional from – whereby the main benefit factors (HSS x BSS) are multiplicative and the subfactors are added up to get a main factor. This approach implies that a poor performance in one main factor (e.g. the HSS) can not easily be compensated by a strong performance in another main factor. Moreover, the cost factor of the BBI is not embedded in the benefits calculation, unlike in the EBI, which provides an objective cost-benefit-evaluation of the sites. Another advantage of the BBI is that it uses information from two critical perspectives for calculating the biodiversity benefits – namely the regional scale information (e.g. vegetation and species conservation status, position in the landscape) and information from the sites scale (e.g. vegetation type and quality, rare and threatened species populations and habitat suitability, landholders actions).

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understorey, logs, fallen branches and leaf litter; and supplementary planting into existing patches of native vegetation" (DSE 2009a: 3).

Besides the positive features there are also some critical aspects to be mentioned. A critical issue of the BushTender trial and the adoption of the BBI is that it carries high transactions costs. On-site research, ecological scoring and administrative costs of the auction process amounted in the first trial to approx. 50-60% of the budget used in the auction. But these costs are assumed to diminish as experience is gained over. Also it might be criticised is that a lot of sites of high biodiversity significance are not successful in the bidding process, because the respective landholder offers a poor value for money bid. Doubtful is whether this payment scheme design is an appropriate conservation instrument for sites of high biodiversity value. The last controversial issue concerns the application of the habitat hectares approach. PARKES ET AL. (2003) state that the approach has to be regarded critically for an assessment of all treeless vegetation types (e.g. grasslands and wetlands), because the 'site condition' assessment criteria mainly concentrate on attributes that are related to trees. Therefore is can be criticised that this approach is adopted in the BBI for the assessment of all vegetation types.

4. Suggestions for the design of an agri-environment index

4.1.1. Basic considerations

Based on experiences from the EBI and the BBI, suggestions for the design of an AEI – considering its adoption in a payment scheme for biodiversity conservation in grasslands – will be discussed. Before analysing which potential individual factors an AEI should contain, some pre-considerations have to be outlined.

In order to design an AEI, it is first of all important upon which specific grassland types the payment scheme will concentrate on. Shall all grassland types be able to participate in the scheme? Or shall only so far extensively managed grassland types be able to participate, as recommended by KLEIJN AND SUTHERLAND (2003). Further suggestions about the design of an AEI will be based on the assumption that species-poor intensive used grassland types and sowed grassland and miscellaneous pastures will be excluded from participation in a payment scheme.[5] In this case it seems useful to determine specific criteria that can identify the target grassland types and exclude all other types from participation.

Former advantages and disadvantages have shown that a hybrid functional form (according to the BBI) – whereby several sub-factors are added up to build a main factor and the main factors are multiplied to get the benefits score – is practical and recommendable for calculating prospective conservation benefits. This approach gives each main benefit factor

[5] A similar approach can be found in the result-orientated AES of Lower Saxony (MOST ET AL. 2006).

more weight than in a purely additive calculation (like in the EBI), because a poor performance in one main factor can not easily be compensated by a strong performance in another main factor. For that reason, the suggestion for the design of an AEI will be built upon this hybrid functional form.

The design of an AEI is dependent on the scheme configuration. Further suggestions about the AEI will be made on the basis of a payment scheme configuration that is action- and result-orientated, in order to share the risk of failing the environmental goal between landowner and conservation agency. Moreover, it will be assumed that the potential participators will be selected by a conservation procurement auction with discriminatory payments, because this scheme outlay is suggested to use public funds more cost-effectively than current fixed flat-rate payment schemes (e.g. LATACZ-LOHMANN AND VAN DER HAMSVOORT 1997; STONEHAM ET AL. 2003; CJC CONSULTING 2004; NATIONAL MARKET BASED INSTRUMENTS WORKING GROUP 2005; GROTH 2007; GROTH 2009).

4.2. Quantifying the benefits for biodiversity conservation

In order to quantify prospective biodiversity conservation benefits, three main categories will be considered similar to the BBI. The 'Conservation Significance Factor (CSF)' mainly reflects attributes that are suggested to positively affect the ecological quality of a site and point out its significance for biodiversity conservation in grasslands. Whereas the 'Connectivity Factor (CF)' regards the conservation significance from a regional perspective and evaluates the function of the site in the broader landscape (e.g. how it is integrated in a broader habitat network). The 'Conservation Management Factor (CMF)' is supposed to estimate the potential biodiversity outcomes from the landholder's management actions. These three main factors – the conservation significance of the site, spatial influences and a steady conservation management – are identified to be important factors for the performance of conservation payment schemes. The factors will be discussed with regard to specific evaluation criteria and corresponding assessment approaches. There will be no precise suggestions for the weighting of each factor.

4.2.1. Conservation Significance Factor (CSF)

Regarding the Conservation Significance of a grassland site, three different criteria and respective assessment approaches will be discussed.

First of all it is questionable if a grassland site of larger size can be regarded as serving better for biodiversity conservation than a site of smaller size. If there may be a positive correlation between area size and biodiversity conservation in grasslands, the AEI should contain a size factor. For comparison, the EBI does not contain a size factor, whereas in the BBI the size is regarded in calculating the current site quality and the BSS. Between ecologists this question is discussed controversially in the so called SLOSS-debate – Do *single large or several small* areas serve better for nature conservation? The origin of the debate began with the thesis of DIAMOND (1975) that one single large area is preferable to several small areas for the survivability of species, with the assumption that all areas are of the same type of environment. Many kinds of species (especially large carnivores) can be better protected in larger habitats, because these can contain larger populations and feature a wider range of environmental conditions (HUNTER AND GIBBS 2007). But LESICA AND ALLENDORF (1992) state that smaller patches play an important role for conserving plant species, because small plant populations within stressful environmental conditions loose their genetic variability more slowly than plant species in more benign environments. Moreover, VIROLAINEN ET AL. (1998) point out, that several small mires contain more vascular plant species as well as more rare species and a higher taxonomic diversity than a single large mire of totally equal size. One conclusion of this debate can be that both large and small habitats are valuable for nature conservation. Large patches should be protected in order to minimize extinctions, and small reserves to maximize species diversity. As a result of this controversial debate, it will be not recommended to integrate a size factor in an AEI.

For determining the conservation significance of a grassland habitat (resp. the pre-condition of the site), it is possible to evaluate if several indicator species occur on the site that signify extensively managed and species-rich grassland of notable conservation significance. It has been shown that a quantification of pre-defined indicator plant species on a specific site is positively correlated with the actual plant species richness of this site in the most examined cases (MOST ET AL. 2006). This aspect makes the approach interesting for an application to determine different levels of conservation significance of grassland habitats. But there are also some difficulties. Since plant species are dependent on the region and specific grassland types, one cannot simplify that a site with e.g. 12 flowering indicator plant species is of higher conservation significance than a site with e.g. 8 indicator species. For instance, certain wet and humid grassland types feature frequently not a certain amount of the pre-defined indicator plant species. Therefore it is regarded critically to use this method in the AEI. The approach was basically designed for a result-orientated payment scheme in order to exclude species-poor intensively used grasslands from participation and to distinguish between species-poor mesophile grassland and species-rich mesophile grassland as well as grassland types of category. Hence, it would make no sense to build more that these two 'vegetation quality levels', because for increasing levels (of 7 and more indicator species) an uniform indicator species list cannot be adopted for identifying higher conservation significance levels over different regions and grassland types.

Another approach is not to look at specific species but to identify grassland types (due to a common vegetation classification) and to rank different types according to their conservation significance, like in sub-factor N1a of the EBI. A difficulty in this approach can be to determine objective criteria why, for instance, grassland type x is of higher significance than grassland type y. According to the BBI, vegetation types can be ranked based on their regional degree of exposure. But how can that be applied on German grasslands? A possible approach is the 'red list of vulnerable German habitat types' (RIECKEN ET AL. 2006), in which the conservation significance of German habitat types is evaluated by one quantitative and one qualitative criterion: i) the vulnerability of habitats due to area decline (quantitative) and ii) the vulnerability due to qualitative alteration (as a result of negative anthropogenic impacts on e.g. structural habitat characteristics and/or on habitat-typical species composition).

4.2.2. Connectivity Factor (CF)

The success of species conservation depends to a large extend on the connectivity of the site. HUNTER AND GIBBS (2007) state that connectivity ensures four basic kinds of species movements: i) relatively small-scale daily movements of fauna species among the patches of their preferred home-range habitat, ii) annual migrations of animals, iii) dispersal movements, which are vital for keeping the species of a patch connected with other populations and iv) range shifts of species due to changing environmental conditions, like climate change. All in all, the design of a connection should depend on the kinds of organisms and the types of movements it was intended to accommodate (HUNTER AND GIBBS 2007).

For evaluating the connectivity of sites the EBI formerly measured the distance to the next protected area, whereas the BBI contains more comprehensive connectivity measures. The Habitat Score – that determines the current site quality – includes two connectivity measures: 'neighbourhood' and 'distance to core area', which are both assessed by using a geographic information system (GIS). The neighbourhood factor evaluates the degree of linked and unlinked surrounding native vegetation by laying three radii (of 100m, 1km and 5km) around the centroid of the concerned site. Then it will be approximately assessed what proportion of the area within a circle is covered by native vegetation, by using 20% intervals. After multiplying each factor with a specific weight, the scores are summed up and determine the total neighbourhood score.

The second connectivity measure ‘distance to core area’, assess the distance to the nearest patch of native vegetation which is greater than 50 ha: 5 SP are rewarded for a contiguous patch, 4 SP (score points) for a distance under 1 km, etc. Regarding the BBI, the connectivity is also being assessed in the BSS but more precise information about this calculation is not provided in the official document (DSE 2008a).

The last approach of measuring connectivity as the distance to the nearest core area is discussed controversially. MOILANEN AND NIEMINEN (2002) state that so called nearest neighbourhood measures are too simple for most terrestrial metapopulations because other patches that are within an adequate migration range from the focal patch are neglected. Other connectivity measures, like the neighbourhood analysis that belongs to the so called ‘buffer measures’, are evaluated to be more complex and precise. But for a well working connectivity measure, the radius of this method has to be optimally chosen depending on the particular habitat structures. Furthermore, regarding this method two points can be seen controversially. First, all patches within a given radius are regarded but these patches are weighted equally and the distance effect is not included. Moreover, buffer measures are step function of distance, which implies that patches outside the radius cannot be colonized. This makes them unrealistic for predicting large-scale dynamics of meta-populations. Another option is the use of so called ‘Incidence Function Models’ (IFM), that take into account distances to all possible source populations and the migration range distribution. But this measure can only be adopted if this comprehensive information (about e.g. the mitigation range distribution) are known and if only a few specific species are considered. Therefore, the IFM measure seems to be not convenient to be adopted in an AEI and measuring the distance to the next core area (nearest neighbourhood measure) is too simple. Hence, it is discussable if a buffer measure, like the neighbourhood analysis of PARKES ET AL. (2003) (or a similar buffer measure) is an appropriate approach for measuring the connectivity of sites for the AEI.

4.2.3. Conservation Management Factor (CMF)

The Conservation Management Factor can evaluate the following aspects. Due to the precondition that the AEI is supposed to be adopted in a result- and action orientated payment scheme it makes sense to include an evaluation of the specific conservation actions the landholder is supposed to undertake. Another aspect that is useful to be assessed is if the landholder has formerly managed the site extensively (with no fertilizer application etc.), which is suggested to be a decisive question for the performance of conservation schemes. In this respect the continued motivation of farmers to participate in the payment scheme is also vital for the prospective conservation of the site.

Regarding the question which conservation actions should be evaluated and rewarded with different SP, further knowledge about how far different forms of conservation management actions affect grassland biodiversity in a positive way is needed. In the EBI – more precise in factor N1a – different cover practices (CP) are regarded and those that are suggested to be more beneficial for biodiversity conservation are assigned more SP, than CP that are regarded to be less beneficial. But this approach is more result-orientated than action-orientated. The BBI considers potential maintenance gain in the HSS for protecting the current site quality and potential improvement gain for conservation actions that go beyond legislative obligations and improve the quality of the site. This basic concept seems convincing, although the particular method of regarding the maintenance and improvement of individual factors of the 'habitat hectares approach' of PARKES ET AL. (2003) can not be adopted in grasslands.

Hence, a list of possible management actions that maintain and/or enhance biodiversity in grasslands can serve for evaluating the action-based component of the AEI. In this regard the regulations of the EAFRD Regulation have to be taken care of, so that only actions which go "beyond the relevant mandatory standards"(EAFRD REGULATION, article 39(3)) are rewarded in the AEI. Some conservation measures that are vital for grassland biodiversity conservation should be determined as obligatory, like the abandonment of fertilizer application on the specific site. Which explicit conservation management actions the list should contain and what SP are rewarded can not be answered in this scope.

Furthermore it is suggested to reward SP to landholders who formerly participated in conservation payment schemes, similar to the factor 'prior management gain' in the HSS. Thus, the enduring existence of already 'produced' ecological values is aimed to be secured. Likewise it is suggested to reward SP for the length of the prospective contract obligations (how long the landholder is willing to take part in the conservation payment scheme), according to the factor 'length of contract' of the HSS in the BBI. For both aspects the number of years can be counted: years of prior conservation management plus years of prospective management obligations. Another option is to cluster the years and assign certain categories to different score point levels: e.g. 5 SP for 1-5 years of prior (prospective) management, 10 SP for 6-10 years, etc.

4.3. Quantifying the costs of biodiversity conservation

There are several ways how the cost factor can be included in an AEI. Within a first approach all cost considerations are excluded from the evaluation procedure, thus the AEI does not include a cost factor. This means that those applications with the highest environmental score are accepted – regardless how costly they are – until the budget is exhausted. This approach is for instance used in the current result-orientated schemes with fixed flat-rate payments of Lower Saxony and Baden-Württemberg. When costs are excluded from the evaluation procedure, applications that do not reach a certain environmental score are rejected although they are probably more environmentally cost-effective than applications above the cut-off line that are accepted. If the instrument conservation procurement auction (with discriminatory payments) – as a pre-condition for the design of the here proposed AEI – is applied to this approach, the amount of payment can be assigned for instance to the environmental score. E.g. for a score of 200 points the landholder gets 200 $/acre (€/ha). But this is an uncommon approach – usually conservation procurement auctions with discriminatory payments include a cost factor in their evaluation procedure and the payment depends on the landowners offer.

The second approach is applied in the Australian BushTender trial, whereby applicants are assessed on the basis of a benefits-to-cost ratio. An outstanding advantage of this approach is that a larger number of applicants and hence acres (or ha) will be accepted by the programme in comparison to the first approach. This may possibly lead to an overall higher level of budgetary cost-effectiveness. A disadvantage is that some applicants may only be accepted because their adopted conservation measures are very cheap and hence provide only minimal conservation benefits. A solution might be an obligatory minimum level of conservation benefits.

The third approach is an intermediate one as applied in the US-American CRP in which additional points are rewarded for cost-effectiveness. The more cost-effectiveness is emphasised by the payment scheme the steeper is the slope of the cut-off line.

4.4. Suggestions for the design of an AEI

According to the previous findings, an AEI that can be adopted in a result- and action-orientated payment scheme for biodiversity conservation in German grasslands with discriminatory payments can be structured as follows. The general design of the AEI is suggested to be a benefits-to-costs ratio – conservation benefits as numerator and the costs as denominator – according to the BBI:

$$AEI = \frac{CSFxCFxCMF}{CostFactor}$$

Conservation Significance Factor (CSF): The CSF can be determined by the respective grassland type (ascertained due to a common vegetation classification) and its conservation significance – vulnerability degree of quantitative area decline and qualitative habitat alteration – according to the German red list of vulnerable habitat types.

Connectivity Factor (CF): The CF can be determined by a connectivity measure, like a buffer measure (e.g. similar to the approach of the neighbourhood analysis of Parkes et al. (2003)).

Conservation Management Factor (CMF): The CMF can be determined by a list that contains a broad range of management activities that serve for grassland biodiversity conservation. Each management activity is assigned a certain number of SP according to how effective this measure is estimated for maintaining or enhancing biodiversity conservation in grasslands. Additionally the years of former participation in a conservation scheme as well as the years of future contract obligations can be accounted in the CMF.

Cost Factor: The cost factor can be determined by taking the respective bid price per hectare (€/ha) of each applicant into account. Because there is no size factor in the numeration, an absolute measure like the full bid price cannot be used for an evaluation. Therefore a relative measure (e.g. costs per hectare) – like in the EBI will be suggested in this context.

Since species-poor intensively used grassland types as well as sowed grassland and miscellaneous pastures will be excluded from scheme participation the payment scheme needs an approach to determine the threshold for participation. For this purpose the approach of using a pre-defined index list of flowering plant species to identify extensively managed and species-rich grassland should be adopted.

5. Conclusion

The conservation of biodiversity in grasslands depends mostly on payment schemes that mainly stipulate specific conservation management activities – so called action-orientated AES. Certain aspects, which are critical for the performance of those schemes, are formally not considered and evaluated, like e.g. the precondition and connectivity of the funded grassland site. For enhancing the success of payment schemes for biodiversity conservation in grasslands as well as the budgetary cost-effectiveness of funding such sites, a certain scheme design is regarded to be promising. Such a scheme selects its participants in a conservation procurement auction process by applying an AEI that evaluates different result- and action-based criteria, which should quantify the prospective benefits and costs of biodiversity conservation on a specific grassland site. Successful applicants receive a payment that is based on their individual bids (discriminatory payments), which mostly reflect their costs for provisioning and managing the property for biodiversity conservation.

On the basis of the previous findings, the recommended design of an AEI is as follows. The general structure should be a benefits-to-costs ratio with a quantification of the prospective benefits of a grassland site for biodiversity conservation in the numerator and a cost factor in the denominator. The evaluation of the benefits contains three factors: the Conservation Significance Factor (CSF), the Connectivity Factor (CF) and the Conservation Management Factor (CMF). The Cost Factor can be determined by taking the respective bid price per hectare (€/ha) that the applicant will demand as compensation payment for the conservation services.

There should be no doubt, that it is important to change the current practice of payment schemes for biodiversity conservation and to implement schemes that effectively induce incentives to maintain grassland sites that are of high conservation significance. An AEI seems to be a convenient instrument to identify applicants who can provide biodiversity conservation on high-quality grassland habitats at low costs and thus to allocate limited public funds in a cost-effective way. The here given suggestions for a general design of an AEI as well as specific factors and methods to determine these, may be a contribution to further interdisciplinary discussion.

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