

Review

Identifying and managing the conflicts between agriculture and biodiversity conservation in Europe—A review

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Received 20 December 2006; received in revised form 31 August 2007; accepted 6 September 2007

Available online 22 October 2007

Abstract

This paper reviews conflicts between biodiversity conservation and agricultural activities in agricultural landscapes and evaluates strategies to reconcile such conflicts. Firstly, a historical perspective on the development of conflicts related to biodiversity in agricultural landscapes is presented. Secondly, recent trends in agricultural policies of the European Union that contribute to biodiversity decline in agricultural landscapes are considered. Three major processes responsible for creating biodiversity-related conflicts are described: the intensification of agriculture, the abandonment of marginally productive but High Nature Value Farmland, and the changing scale of agricultural operations. Conflicts created by these processes and approaches to their reconciliation are identified, emphasizing the need for monitoring as an integral part of conflict reconciliation strategies. A generic approach comprising three types of monitoring is developed for measuring success of reconciliation strategies: monitoring of the intensity of the conflict between stakeholders, of the social and economic effects on farmers, and of the status and trends in biodiversity. Surprisingly, we found no evidence in the literature that the first type of monitoring has ever been undertaken for biodiversity-related conflicts in agricultural landscapes. For each type of monitoring, suitable indicators are outlined. Finally, challenges for conflict management in agricultural landscapes are summarized.

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Keywords: Abandonment; Agricultural landscapes; Agricultural policies; Biodiversity conservation; Conflict reconciliation; Intensification; Monitoring; Stakeholders

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1. Introduction

Agricultural landscapes cover over 45% (180 million ha) of the enlarged European Union (EU 27). This is divided into arable land (nearly 103 million ha), permanent grassland (65 million ha), and permanent crops (12 million ha) (FAO-STAT, 2005). Agricultural landscapes show a wide range of ecological conditions and differ considerably in terms of their biodiversity depending on a combination of factors, such as soil condition, water availability, climate, slope, and management factors, for example type, intensity, and scale of use (Mühlenberg and Slowik, 1997; Pain and Pienkowski, 1997). High Nature Value (HNV) farming systems¹ and their associated management practices can be highly beneficial to biodiversity (e.g. Bignal and McCracken, 2000; EEA, 2004; Pain and Pienkowski, 1997) and in Europe, the maintenance of the biodiversity of many ecosystems depends directly on traditional types of agricultural land use (Mühlenberg and Slowik, 1997; Poschlod and Bonn, 1998).

However, the range of traditional types of agricultural landscapes is dramatically decreasing across Europe due on the one hand to partial or complete abandonment of farmland (e.g. Mühlenberg and Slowik, 1997) and, on the other hand, to intensification of land use. Consequently, some of the most critical conservation issues today relate to changes in traditional farming practices on habitats, such as

hay meadows, lowland wet grasslands, heathlands, chalk and dry grasslands, moorlands, and arable land. These habitats usually disappear after the abandonment of traditional farming practices. Equally, species adapted to the diversity of structures or resources of HNV farmlands cannot survive under increasingly high intensity agricultural management (e.g. Chamberlain et al., 2000; Firbank, 2005). Overall, these changes in agricultural management have greatly reduced biodiversity and threaten the survival of many species (Mühlenberg and Slowik, 1997; Pain and Pienkowski, 1997; Poschlod and Bonn, 1998). Thus, it is vital to ensure that the intensity of agricultural management is appropriate for biodiversity conservation (Bignal and McCracken, 2000).

The aim of this paper is to review circumstances where agricultural activities and interests (mostly geared towards economic gains) clash with the conservation of biodiversity in agricultural landscapes. The first part of the paper identifies historical and current anthropogenic threats to biodiversity in agricultural landscapes, which lead to conflicts. In the second part, a generic approach to conflict management and monitoring is developed, with an emphasis on stakeholder participation. Notwithstanding, one needs to recognise that types of conflicts and options available for biodiversity conservation differ among European regions (Meeus and Wijermans, 1990; Mühlenberg and Slowik, 1997). As such, each conflict has to be dealt with in a unique manner, according to the species and habitats as well as the particular socio-economic characteristics of the region involved. It is, however, feasible to consider a generic framework in which such locally appropriate approaches and decisions can be set. The term “conflict” used here

¹ Three broad types of High Nature Value Farmland are recognized in Europe (EEA, 2004): Type 1, farmland with a high proportion of semi-natural vegetation; Type 2, farmland dominated by low intensity agriculture or a mosaic of semi-natural and cultivated land and small-scale features; Type 3, farmland supporting rare species or a high proportion of European or world populations.

refers to situations where disputes drift outside settled social mechanisms (Hellström, 2001: 12).

2. History and current trends in biodiversity conflicts

Many of the habitats that are valued now for biodiversity across Europe are a direct result of traditional agricultural practices established during agricultural expansion (Bignal and McCracken, 2000). However, by the end of the 19th and beginning of the 20th century, a marked decline in extensively used grassland and pastoral land, bogs, and small wetlands occurred due to new developments in agricultural technology (Ellenberg, 1996; Mühlenberg and Slowik, 1997). This intensification was recently accelerated under the Common Agricultural Policy (CAP) in Western Europe (Mühlenberg and Slowik, 1997; Stoate and Boatman, 2001) but also in Eastern Europe to supply the Soviet Union market with agricultural products (Young et al., in press).

2.1. The Common Agricultural Policy

By the 1980s, the Common Agricultural Policy and its market and structural support policies were held responsible for increasing habitat degradation, overproduction of food products, intensification of farming practices, and the concentration of production from fewer, more specialised farms (Bignal et al., 2001). With increasing environmental awareness in Europe, these conflicts between agricultural production, biodiversity, and the human environment became increasingly apparent and caused a re-thinking of agricultural policies and practices. As a result, in the early 1980s, the CAP experienced the first of a succession of changes in emphasis with new measures introduced to control surplus production and to provide compensation to farmers for loss of income for adopting environmentally sensitive forms of farming. The subsequent 1992 reform further recognised the environmental role of farming by increasing the availability of agri-environmental schemes across the EU. In 1998, the Agenda 2000 reform took these further and introduced elements of environmental cross-compliance, as well as the opportunity for farmers to obtain support (under the Rural Development Regulation) for additional activities other than farming per se. Farmsteads are now expected not only to produce food but also to promote biodiverse and cultural landscapes, with stakeholders from different sectors increasingly calling for different goals.

The ‘mid-term’ review of the CAP in 2003 has served to remove the focus on production and has increased the focus on environmental concerns within the CAP. Now farmers receive a Single Farm Payment (which in the EU-15 is largely based on their historic level of CAP support), provided they comply with a range of EU Directives

(including the Birds and Habitats Directives) and maintain their land in good agricultural and environmental condition. This should not only address biodiversity conservation needs but also other goals, such as water management and soil protection.

The success of agri-environmental schemes in terms of achieving biodiversity conservation goals varies across Europe and has often been debated (e.g. Kleijn and Sutherland, 2003; Kleijn et al., 2004; Wätzold and Schwerdtner, 2005). Whereas studies in the UK tend to show biodiversity benefits (e.g. Hanley et al., 1999; Peach et al., 2001), in other countries, such as the Netherlands, the biodiversity benefits of agri-environmental schemes are less clear (e.g. Kleijn et al., 2004). Furthermore, a halo effect may develop where small parts of the farm operate under the scheme while the majority still remains intensive, thereby restricting wildlife corridors or improved catchment performance as has been observed in the UK (Hanley et al., 1999). A recent meta-analysis across Europe showed that the effect of set-aside schemes on species richness and population density depends on the age of the set-aside area, the total area managed under set-aside schemes, and the intensity of agriculture (Van Buskirk and Willi, 2004).

No similar analysis is available on the acceptance of agri-environmental schemes by farmers across different European regions. There are also some limitations to agri-environmental schemes, e.g., farmers can adopt any kind of farming practice once the contract finishes, thereby potentially cancelling ecological benefits accrued during the contract period.

2.2. Current trends

The major pressures currently affecting farmland biodiversity across Europe are agricultural support policies, international trade negotiations, biomass production for energy, and policies on the use of genetically modified organisms (GMOs). Indirect influences are caused by the enlargement of the EU and the implementation of nature conservation policies.

The current changes to the CAP support mechanism are expected to indirectly result in a decrease in pressure on biodiversity and other elements of the agricultural environment from intensive farming practices within the EU. However, any reversal of biodiversity loss is not anticipated to be uniform across all agricultural sectors. Indeed, it is likely that dairy farms in particular will continue to have an adverse impact as economic pressures drive those farmers who continue in this sector to increase herd sizes and the associated area of land that they farm. In addition, although current input rates are relatively low on farmland in eastern European countries, intensification is expected under the new economic and political framework following accession of these countries to the EU. It is therefore likely that areas of High Nature Value farmland will also be prone to intensification in the near future causing conflicts between

agricultural production and biodiversity protection (EEA, 2004).

While there has been considerable criticism of EU policy on afforestation of farmland in the past, there have been improvements in the relevant legislation, most notably under the Rural Development Regulation. As a result, intensive large-scale planting in the EU has declined. However, a focus on commercial objectives and a narrow range of tree species can still result in damage to areas of high biodiversity value, and disruption of pastoral agricultural systems, including transhumance. In Ireland, for example, progress is being made in developing more sensitive and appropriate approaches to afforestation. However, problems remain, such as the tendency to guide afforestation with conifers onto small blocks of agriculturally unrewarding pasture on farms, even though these may be the most valuable areas for conservation or the last remaining patches of semi-natural vegetation. Methods of targeting afforestation to suitable sites, avoiding HNV farmland, such as semi-natural grassland and heathlands for example, could be more widely used to reduce conflicts (McCracken, 2004).

New agricultural production methods and irrigation also can play an important role in the development of agricultural sectors in Europe. For example, the increase in both the irrigation area and the agricultural area installed with irrigation equipment indicate that water used by the agricultural sector increased during the period 1990–2000. This has produced a conflict with other uses of water and has placed an important pressure on water resources, especially in southern Europe where a much greater efficiency of water use by agriculture is needed to prevent seasonal water shortages. Although the land equipped for irrigation increased steadily in the 1990s, this trend has since been less pronounced, except for France, which has experienced one of the highest increases in its irrigated area (related to changes in crop cultivation since approximately 40% of the land irrigated at least once a year is now used for growing maize). In 2000, Italy had the highest irrigated area (3.9 million ha) followed by Spain (3.5 million ha). The substantial expansion of the irrigated area in France and Spain was influenced by policy measures supporting the provision of irrigation infrastructure and providing subsidies for farmers installing irrigation equipment, as well as guaranteeing low water prices for agriculture (Campling et al., 2003).

2.2.1. International trade negotiations and agreements

The agricultural markets of the EU and other industrialized countries are not only heavily subsidised, they are also protected against international competitors. Recent political discussions at the G8 summit and negotiations at the World Trade Organisation (WTO) indicate a slow opening of agricultural markets, which may cause new conflicts between agriculture and biodiversity protection. For example, the liberalisation of the sugar trade will benefit the sugar industry of developing countries but will accelerate

biodiversity loss due to the expansion of sugar cane production (AgrarBündnis, 2005). In the EU, in contrast, sugar beet production will probably decrease although this may differ from region to region; this will also depend on whether new market possibilities develop for sugar beet as a feedstock or as source for bio-energy. Sugar beet cultivation can be extremely harmful to the environment as farmers increasingly rely on large quantities of pesticides to control the various diseases affecting sugar beet (Kaffka and Hills, 2002). Thus, these changes in WTO agreements may benefit biodiversity in European agricultural landscapes—but at the expense of biodiversity in developing countries.

2.2.2. Genetically modified organisms in agriculture

The Cartagena Protocol regulates international trade in genetically modified organisms. In the EU the introduction of GMOs requires evidence of absence of harm to biodiversity compared to conventional varieties. As of 2002, only four European states have cultivated genetically modified agricultural plants in Europe: Spain, Germany, Romania, and Bulgaria (www.zeit.de/2003/42/gentechnik). Nevertheless, recent media coverage in Germany and the UK (e.g. www.zeit.de/2003/42/gentechnik; Special Issue 140, 2006, of *Ökologie & Landbau: Öko-Landbau ohne Gentechnik*) show that the use of GMOs in agriculture remains a hotly debated issue with potential for severe conflicts.

The main biodiversity related issue discussed in the public and political arena is the risk of transfer of genetic material to wild species (e.g. Breckling and Verhoeven, 2004). GMOs are also regarded as a major risk to the future of eco-farming, which is why in Germany, for example, 11,000 farmers have organized themselves into over 50 GMO-free zones (AgrarBündnis, 2005). More generally, the introduction of GMOs also carries another, more wide-reaching risk for biodiversity by encouraging another step in the direction of further agricultural intensification, with potential benefits of reduced pesticide requirements still being debated (Breckling and Verhoeven, 2004; Firbank and Forcella, 2000). However, such concerns over the impacts of biodiversity at a landscape scale are not solely confined to GMOs but have also been raised with regard to the introduction of any new crops requiring intensive management (such as biofuels) becoming more common in the countryside (Sutherland et al., 2006).

2.2.3. Enlargement of the EU

In the past, the expansion process of the European common market and the European Union has magnified the trends of intensifying agriculture on productive lands, abandoning marginal lands, and changing the scale of operation in the countries that joined the EU. In Spain, for example, the entry into the Common Market triggered major changes in livestock production, agricultural intensification, and social discontent leading to rural depopulation, which in turn affected biodiversity (Pérez, 1990; Plieninger et al.,

2003). Similar changes occurred in Portugal (Moreira et al., 2001) and Greece (Lyrintzis, 1996).

The most recent expansion of the EU has brought many biodiversity-rich areas under EU legislation, with similar impacts as previous enlargements. The percentage of abandoned agricultural land is high in most eastern European countries ranging between 10% and 50% (Kull et al., 2004) despite EU funding having allowed, for instance, an increase of the subsidies for the management of semi-natural meadows.

2.2.4. Nature conservation policies

The main policy instruments for site protection at EU level are the Birds and Habitats Directives (79/409/EEC, 92/43/EEC). Annex I of the Habitats Directive lists natural and semi-natural habitat types that must be maintained in or brought into a favourable conservation status by the Member States. The Natura 2000 network will build on the proposed sites of community interest (pSCIs) that have been listed by the Member States. Out of the 198 habitat types listed in Annex 1 of the Habitats Directive, 65 have been shown to be threatened by the intensification of agriculture practices, while 26 grazed pasture habitats, and 6 mown grassland habitats are threatened by the abandonment of pastoral management practices (Ostermann, 1998).

However, despite the dominance of farmland across Europe, agricultural habitats only form about 35% of the total area listed as pSCIs across the EU-15 and only three countries (Greece, Portugal, and Spain) have included a greater proportion of such habitats within the pSCIs they have listed (McCracken, 2004). In addition, it appears unlikely that the choice of farmland to enter into pSCIs has been influenced solely by its biodiversity value, since less than a third of the predicted distribution of HNV farmland areas across the EU-15 has been found to be covered by pSCIs (EEA, 2004). Consequently, it would appear that the site protection measures employed to-date will at best conserve a minority of HNV farmland and do not necessarily appear to be targeted at areas of high farmland biodiversity potential within the more intensively managed agricultural landscapes.

In addition, the establishment of the Natura 2000 network has met with mixed success across Europe. In the UK, many landowners involved (approximately 25,000) have long been used to the issue of statutory designations and so the relatively recent proposals for Natura 2000 simply comes on top of an already well established system of both regulation and financial incentives (Sheail, 1995). Similarly, in Estonia, which has a strong nature conservation tradition, the designation has mainly met with understanding (Otsus and Harak, 2005). In Germany, in contrast, there has been strong local opposition to the designation of Natura 2000 sites partly because of the fear that established systems for agri-environmental schemes, which some farmers depend on, will no longer apply or be more difficult to access (Stoll-Kleemann, 2001). This fear

was partly provoked by little or no communication, due to the Länder governments having underestimated the need for adequate stakeholder information and the associated administrative commitment. Similarly, in France, the implementation of the network was questioned by a number of stakeholder groups (mainly the farmers, hunters, and foresters) and ultimately caused the national suspension of the directive – or “freezing of Natura 2000” – in 1996 (Alphandery and Fortier, 2001). Other examples include Finland, where the network caused major conflicts between landowners and environmental authorities and ultimately affected countrywide attitudes towards biodiversity conservation (Nieminen, 2004).

3. Conflict management and monitoring in agricultural landscapes

The processes in agricultural landscapes created by agricultural policy can be classified into three categories that may lead to conflicts with biodiversity conservation (Table 1). While nitrogen input and generally the input of agro-chemicals is one of the most important conflicts associated with the intensification of agriculture throughout Europe (Blumenbach, 1971; Ellenberg, 1991; Kull et al., 2004), the most serious conflict in Mediterranean countries and the new member states is the dualism of conversion of extensively used land into high intensity production areas and the loss of large tracts of extensively used agricultural landscapes through abandonment (Portugal: Moreira et al., 2001; Spain: Comins et al., 1993; Greece: Lyrintzis, 1996; Eastern European countries: Kull et al., 2004). In Central Europe, abandonment of agriculture and the fragmentation and loss of valuable habitats are usually of more concern for biodiversity conservation than further intensification of agriculture (Mühlenberg and Slowik, 1997).

3.1. Conflict reconciliation strategies

Creative management securing the integrity of ecosystems and the livelihoods of people is of fundamental significance to the resolution of biodiversity-related conflicts (Stoll-Kleemann and O’Riordan, 2002; Niemelä et al., 2005). A range of approaches is available for agricultural landscapes (Table 1).

3.1.1. Regulatory approaches

European-wide (especially the Birds and Habitats Directives) and national legal and administrative approaches have been used widely to reduce the pressure of many threats to biodiversity in agricultural landscapes (Table 1). The same principle is followed in the establishment of nature reserves, with the European Natura 2000 network being the world’s largest network in terms of number of conservation areas, comprising over 25,000 sites and covering an area of 1 million km² (European Commission, 2007).

Table 1
Reconciliation strategies for major conflicts between agriculture and biodiversity

	Types of conflict												
	Intensification				Abandonment						Scale of operation		
	Fertilisers	Biocides, endocrine and antibiotic substances	Use of GMOs	Conversion of pasture	Afforestation	Urbanisation	Succession	Inadequate management for nature	Loss of ancient varieties	Loss of cultural heritage	Trend to monoculture	Small-scale landscape features	Dispersal processes
Regulatory approaches													
Political and administrative framework	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	
Legal regulations	✓	✓	✓							✓	✓		
Buying land	✓			✓	✓					✓		✓	
Incentives													
Subsidies/compensation	✓			✓	✓		✓		✓	✓		✓	✓
Marketing: healthy products; educate consumers; environmental labelling	✓	✓	✓	✓			✓		✓	✓	✓	✓	✓
Production of tradable environmental goods				✓			✓		✓		✓		✓
Formal contracting	✓	✓		✓			✓	✓	✓	✓		✓	✓
Audit (self audit, external)	✓	✓		✓							✓	✓	
Participatory approaches													
Training (extension personnel and farmers)	✓	✓						✓		✓		✓	✓
Improved access to information	✓	✓	✓					✓	✓	✓		✓	✓
Identification and use of social links		✓	✓						✓	✓	✓	✓	
Mediation; communication among stakeholders			✓					✓			✓	✓	
Identification of goals and vested interests	✓	✓	✓	✓						✓	✓	✓	✓
Improving the role of science in conflict reconciliation	✓	✓	✓				✓	✓					✓

✓/: Strategy judged suitable based on the combined experience of the authors and the BIOFORUM team (see Acknowledgements) and references provided in the text.

Top-down approaches inevitably cause some conflicts to resurface and so generate new conflicts (Young et al., 2003). For example, due to tight legal restrictions for expansion of intensive agriculture in north-western Europe, farmers from these areas have tended to move to Eastern European countries to buy land, re-organise, and intensify agriculture which, in turn, has resulted in political, social, and environmental conflicts in Eastern European countries (Konecny, 2004).

A further regulatory approach is the buying of land and its management for biodiversity purposes, a strategy adopted by several European countries, including the Netherlands (Opdam et al., 2002) and the UK (Henle et al., 2003). The European Union, through the LIFE-Nature instrument, funds projects, including the acquisition of land, that aim to maintain or restore natural habitats and/or species populations to a favourable conservation status. By these means, the EU has allocated approximately €700 million for more than 800 LIFE-Nature projects, with a total budget of €1.3 billion for the period 1992–2005 (www.ec.europa.eu/environment/life). Some NGOs have also developed European-wide programs for biodiversity conservation that include support for the buying of agricultural land. For example, the Stiftung Europäisches Naturerbe currently maintains 20 sites in Europe (www.euronatur.org).

3.1.2. Incentives

The provision of incentives aims at conserving biodiversity while allowing for the economic viability of individual stakeholders. A range of European, international, and national agri-environmental schemes and other funding mechanisms, such as the EU LIFE program and NGO activities, have been set-up for this purpose (Kopaçi, 1998; Lehmann et al., 2005). In addition, private companies increasingly invest in ecologically sustainable agriculture, for example by supporting the IUCN project on Sustainable Agriculture and Steppe Biodiversity in Russia and Ukraine (Goriup, 1998).

Complementary approaches are supportive measures in the marketing of healthy food products and other environmental goods. They have a particularly good potential in connection with local or regional marketing and tourism (Santos-Reis et al., in press). Farmers themselves may join as shareholders to provide funds for the establishment of processing and marketing companies, such as in the German biosphere reserve Schorfheide-Chorin (Henne, 1998). Local marketing may help to maintain grazing regimes that provide local passive dispersal routes for organisms. Such passive dispersal is vital for the evolution and maintenance of regional biodiversity (Poschlod and Bonn, 1998). Local marketing, together with contracting or subsidies, may further help landowners to pilot new approaches, such as the reintroduction of old breeds, a strategy successfully adopted by English Nature throughout the UK. A similar strategy has, however, failed in the Marais Poitevin, France, due to intensive farming practices obtaining subsidies from other

sources making local agri-environmental operations inefficient (Henle et al., 2003).

Increased demands by consumers can stimulate large retail food chains to trade in eco-labelled food, as happened within recent years in Germany. Currently, Germany, Italy, and the UK have the largest markets for organic food. Over half of the land under organic management in Europe is located in Germany, Italy, Spain, and the UK. In the UK, the total organic and in-conversion land, as of January 2006, covered 291,578 ha, equivalent to 3% of the total agricultural area (DEFRA, 2006). Despite this seemingly small proportion of the overall food production sector, the market for organic food in the UK is seeing dramatic increases with growth rates of 30–50% per annum.

Finally, audit is an incentive approach that may help manage biodiversity related conflicts in agricultural landscapes. In the UK, for example, Linking Environment and Farming (LEAF) has developed a self audit farmers can use that covers agricultural operations, such as pesticide and fertiliser use, so as to develop an integrated approach and minimise environmental impact (www.leafuk.org). The EU has set up an audit service for good farming practice but enforcement frequently relies on only a few, well-defined verifiable standards. Only four countries (Finland, Ireland, the Netherlands, and Sweden) have set up codes that contain a more detailed list of more than 50% of the total requirements (Ad Hoc Working Group of the Advisory Committee on Agriculture and the Environment, 2004).

3.1.3. Participatory approaches

Agriculture is a human activity where solutions that involve the participation of local stakeholders may be more successful and sustainable in the long-term than formal ‘top-down’ approaches (Niemelä et al., 2005). For example, in the conflict between hen harrier (*Circus cyaneus*) conservation and the management of red grouse (*Lagopus lagopus scoticus*) for commercial hunting, a participatory exercise promoted dialogue between conservationists and estate managers, and allowed them to better understand different perspectives and values (Redpath et al., 2004).

More egalitarian and network-based communication among all parties, for example in landscape preservation associations, may increase acceptance of biodiversity protection measures. An example is the increasing use in the UK of the whole farm planning approach, with its combination of advice, information, and agricultural best practice (Smallshire et al., 2004). Although still subject to European level agricultural and environmental policies, farmers feel the whole farming approach better meets their needs (e.g. Frost et al., 2004). Another example is the systematic procedure established by the French Ministry of the Environment for any Natura 2000 site in France, which prescribes local management planning, stakeholder feedbacks through local operators, and farmer contracting for land management (<http://natura2000.ecologie.gouv.fr>). Although the procedure did not prevent conflicts at the

beginning, mostly due to a lack of communication, it has made local dialogue possible between stakeholders (Henle et al., 2003).

Close cooperation of scientists with conservation managers and farmers can also play an important role in conflict reconciliation. This was crucial to adapt production methods and technologies to better achieve environmental quality goals in the German biosphere reserve Schorfheide-Chorin. These adaptations led to reduced fertilizer input by precision farming and to reduced applications during periods that are critical for the spawning migration of amphibians (Henne, 1998). Moreover, social scientists have begun to tackle the resolution of both realised and perceived conflicts and developed methods to bring stakeholders together and analyse conflicts within a rational framework through, for example, the method of multi-criteria mapping (Stirling, 1997) and ecological–economic modelling (Wätzold and Schwerdtner, 2005).

Participation of scientists may also be essential when agricultural land is managed for biodiversity since there is no guarantee that the management will not lead to effects contrary to those anticipated. One of the best known example is the extinction of the large blue butterfly (*Maculinea arion*) in the UK following the removal of grazing as a perceived danger and its successful reintroduction once scientists had better understood its biology (Thomas, 1994). Likewise, simplified approaches despite available knowledge may be counterproductive. For example, planting of hedgerows as a measure to improve connectivity decimated the population of the endangered dusky large blue butterfly (*M. nausithous*) in the region of Stuttgart, Germany (Settele et al., 1996). Notwithstanding, care must be taken by scientists becoming involved in conflict resolution since their perceptions and values may differ from those of the farmers and may actually increase the conflict intensity, when scientist are not only a source of information but act as stakeholders (Alard et al., 2003).

3.1.4. Towards a generic approach

The three types of strategies for conflict reconciliation discussed above are not mutually exclusive but complement each other. On the other hand, not all strategies are suitable for the management of all conflicts (compare Table 1) and no conflict can be managed with the use of a single conflict resolution strategy. Thus, best practice must integrate several conflict resolution strategies in such a way as to maximise the contribution of each resolution strategy. The situation is similar for human wildlife conflicts, for which a generic framework for conflict reconciliation has recently been developed (Henle et al., in press) that may serve as a starting point for biodiversity related conflicts in agricultural landscapes.

Such a framework should contain four phases: the screening of the conflict, the assessment of the conflict, the development and implementation of solutions, and finally

monitoring the outcome. The purpose of the screening phase is to raise awareness of key aspects to consider in the development of a reconciliation strategy by a preliminary evaluation of the history, intensity, and dimension of the conflict. The assessment phase has the purpose of improving factual knowledge and understanding of the conflict by evaluating its ecological, socio-economic, and institutional basis. Based on the assessment results, solutions can be developed in the third phase, e.g. with the help of multi-criteria methods (Stirling, 1997) or the combination of ecological and economic models (e.g. Drechsler et al., 2006). In addition, relevant persons and institutions for the implementation process have to be identified. The results will be a conflict management strategy, which includes actions on the ground, work with stakeholders, and recommendations for policy changes, but may also include a return to phase 2 for more in-depth scientific assessment of specific components. The final phase, monitoring, will be dealt with in the next section.

3.2. Identifying monitoring strategies

To ensure the long-lasting success of a conflict reconciliation process, both the intended outcomes for the farmer and for biodiversity have to be assessed. Monitoring needs to be treated as an integral component of the conflict management process, not as an end in itself. It should serve as a feedback mechanism for improving the outcome and the process of conflict management (Niemelä, 2000; Niemelä et al., 2005). We recommend following the generic approach outlined below, adapting it to the specific conditions of the conflict at hand by selecting indicators to be monitored that best fit these conditions.

To make monitoring an integral part of the conflict reconciliation strategy, three types of monitoring are essential: (1) monitoring of the intensity of the conflict among different groups of stakeholders, (2) monitoring of the social and economic effects of the conflict, and (3) monitoring the state and trends of biodiversity.

3.2.1. Monitoring type 1: intensity of conflicts

This type of monitoring addresses the intensity of conflicts among the different groups of stakeholders and how the conflict is affected by the chosen reconciliation strategy. Depending on the strategy chosen, indicators may be considered based on the following (OECD, 1999):

- customer satisfaction questionnaires;
- opinion polls through telephone interviews and questionnaires;
- farmers participation in respective programmes;
- level of active participation of stakeholders;
- attention given to the conflict in stakeholder dialogues, in the mass media, and the political arena (e.g. as measured by the frequency, length, and position on the front pages or in the local pages of newspapers).

Despite its importance (Young et al., 2005), a systematic monitoring of the evolution of conflicts related to biodiversity in agricultural landscapes seems to be exceedingly rare. Since our attempts to find published or unpublished examples failed, we assessed webpages using Google. Using the key words “monitoring conflicts biodiversity agriculture” retrieved approx. 1.8 million entries but only 32 when the words “monitoring of conflicts” were used as a string of characters, and none of them provided an example of practical application for agricultural landscapes (accessed 24.7.2006).

3.2.2. Monitoring type II: socio-economic effects

This type of monitoring is necessary to evaluate whether the intended outcome of the reconciliation strategy for the farmers has been achieved. The choice of indicators for monitoring will be determined by the reconciliation strategy chosen. Possible indicators include (OECD, 1999):

- level of farm income;
- sales of certain products;
- change in the distribution of farmers' income;
- employment in the farming sector;
- number of leisure visitors.

Most of the data for these indicators may be obtained easily through (or minor adaptations of) existing statistics. One example is the EU Farm Structural Survey (FSS), which is held across all Member States of the European Union four times every decade. The survey results help to assess the agricultural situation across the Community and to monitor trends in the structure of holdings. FSS is closely related to the Farm Accountancy Data Network (FADN), which is an instrument for evaluating the income of agricultural holdings and the impacts of the Common Agricultural Policy (see http://ec.europa.eu/agriculture/rca/index_en.cfm; Eurostat Report “Agricultural statistics - Data 1995-2004”).

3.2.3. Monitoring type III: status and trends of biodiversity

Monitoring biodiversity in agricultural landscapes is most often based on indicator species. Generally, good indicator candidates are abundant species typical to the given habitat. Indicator species can be tested to establish how useful or appropriate they are (see McGeoch (1998) and Follner and Henle (2006)). The focal species approach developed by Lambeck (1997), for example, has been shown to provide a suitable framework for selecting appropriate indicator species for various threatening processes (Freudenberger and Brooker, 2004).

Soil invertebrates, fungi, and microbes often allow for a much faster indication of change in agricultural ecosystems than larger long-lived organisms with buffering capacities (Wolters, 2001). However, few indicator systems for soil organisms exist that can be used for monitoring purposes (but see Ruf et al., 2003), partly because of insufficient

scientific attention, and partly because public awareness and values play an important role in biodiversity conflicts, which is reflected in the selection of indicator species. Therefore, plant communities and breeding birds are frequently used as surrogates to assess the status and trends of biodiversity (Chamberlain et al., 2000; Haines-Young, 2000).

Monitoring is also possible at the landscape level by considering the landscape elements that are envisaged in the conservation targets. For example, in Switzerland each farmer is required to manage 7% of his/her farmland as Ecological Compensation Areas (ECA). The features that qualify as ECA include hay meadows, litter meadows, traditional orchards, and hedgerows. In 2002, over 140,000 ha (14% of the Swiss Utilised Agricultural Area) was covered under this designation (Herzog et al., 2005; Knop et al., 2006). Compared with whole farm analysis and the monitoring of individual species, such a focus on broad conservation targets can potentially be achieved with little cost and effort (Carey et al., 2002). Of course, this alone cannot substitute for using biodiversity indicators to estimate the value of a particular piece of land for biodiversity conservation and to control management effects (e.g. Donald and Evans, 2006). To this end, the ECA approach in Switzerland not only involves setting regulations for the management allowed on the ECAs (e.g. late cutting, restrictions in fertilisers and pesticides) but also sets ecological quality criteria, which the vegetation in the ECA needs to conform to (Herzog et al., 2005; Knop et al., 2006).

While it is often possible for stakeholders to agree on broad characteristics of agricultural landscapes and to define measurable indicators, it is impossible, without conflicts or trade-offs, to maximise all of the desirable characteristics of a given landscape. This is because each form of agricultural practice or conservation strategy will favour some and disadvantage other organisms. Therefore, target species systems need to be developed in an agreed hierarchical framework, from the European to the national, regional, and local level (Walter et al., 1998).

4. Conclusions

Measures taken to reduce the impact of human activities on biodiversity have rarely focused on managing the conflict between various land-use alternatives but have addressed the impact indirectly through, for instance, legislation to reduce pollution and the establishment of protected areas. While this approach is valuable, there is an increasing realisation that it is insufficient (Stoll-Kleemann and O'Riordan, 2002). In terms of conflict management, choices must be made and acceptable trade-offs must be agreed and achieved (Niemelä et al., 2005).

Trade-offs could mean a negative conflict resolution at one level in order to achieve a positive resolution at other levels, even according to a given criterion (Wolf and Allen, 1995). Therefore, trade-offs need to be made explicit at each

decision level. As yet, no attempts exist to develop a consistent value and target system or conflict evaluation and reconciliation scheme at a pan-European scale although for the former there are systems on the sub-national scale (Walter et al., 1998). In addition, such value and reconciliation schemes need to be combined with monitoring schemes that are carefully designed and integrate all three types of monitoring discussed above.

Finally, conflicts also have a temporal dimension that influences their resolution. Furthermore, there are national and cultural differences in the characteristics and severity of conflicts (Hellström, 2001). This variation favours quicker, local solutions, whatever the influence of the higher levels in the process. Therefore, sustainable conflict resolution strategies need to take into account the different levels of conflicts and a variety of geographical scale. A major challenge is the assessment of the important variation in biodiversity and drivers of conflict among and between the EU states and the development of tools that support biodiversity conservation while providing social, economic, and culturally fair development opportunities within an integrated European wide process.

Acknowledgments

This paper is based on conclusions from a multi-disciplinary EU-funded project (EVK2-CT-1999–2006) to identify and analyse conflicts between human activities and biodiversity conservation in Europe (BIOFORUM). For more information on the BIOFORUM project please visit the project website on <http://www.nbu.ac.uk/bioforum>. The authors acknowledge comments by Timo Goeschl, Scott Jones, Heidrun Mühle, Peter Nowicki, Isabelle Poudevigne, Felix Rauschmayer, Irene Ring, Andreas Troumbis, Yordan Uzunov, and Frank Wätzold. We thank two anonymous reviewers for their constructive comments.

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