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Agricultural abandonment in mountain areas of Europe: Environmental consequences and policy response

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Agricultural abandonment reflects a post war trend in western Europe of rural depopulation to which isolated and poorer areas are most vulnerable. The commercialisation of agriculture, through technological developments, and the influence of Common Agricultural Policy have increased productivity and focused agricultural activity on more fertile and accessible land thus transforming traditional approaches to farming. In many areas this has lead to a decline in traditional labour intensive practices and marginal agricultural land is being abandoned. The problems that these trends create are particularly marked in mountain areas. The social and economic impacts of these changes have been well documented. However, the implications for environmental policy are less well recognised. This paper reviews the literature on abandonment and gives a comparative analysis of European mountain case studies to assess the environmental impacts of land abandonment and decline in traditional farming practices. It finds abandonment is widespread and that, while the influence of environmental changes is unpredictable due to environmental, agricultural and socio-economic contextual factors, abandonment generally has an undesirable effect on the environmental parameters examined. The application of agri-environment policy measures in relation to abandonment is discussed and suggestions for future policy are proposed.

Keywords: land abandonment; agriculture; agri-environment policy, biodiversity loss, landscape change

Introduction

Agricultural land is abandoned as an economic resource when it ceases to generate an income flow for businesses or households and the opportunities for resource adjustment through changes in farming practices and farm structure are exhausted. Agricultural adjustment may be limited by traditional attitudes, inflexibility in production and fragmented structures (Dax *et al*., 1995), and if alternative, more profitable uses cannot be found (e.g. forestry, recreation) land is abandoned from productive use. In some mountain areas, despite physical difficulties, there are opportunities for diversification: quality produce, agricultural or nature tourism. However, the opportunities for adjustment in farming are dependent on the competitive position of the rural economy and its comparative advantage for different types of economic activity. Baldock *et al*. (1996) have identified the particular vulnerability to marginalisation and abandonment of small and extensive farming systems, and these types of farming systems dominate mountain zones. Nowadays, in mountain areas, extremes of remoteness and physical disadvantage reduce competitiveness and place severe limits on technical and structural adaptation, and mountain people may be less adaptable due to age, constraints on skills, and ingrained tradition (Campagne *et al*., 1990; Walther, 1986) as well having an aversion to risk taking. In particular, in southern Europe low productivity of land combined with small farm size, often made

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up of dispersed farm plots has resulted in very low incomes, and this situation has been compounded by a concentration of agricultural research on increasing the productivity of lowland crops and livestock (Stamou, 1990; Kitsopanidis, 1990).

Specific policy measures for mountain areas have been instituted primarily to provide compensation for disadvantage, although such areas are typically a priority for structural and development assistance. Additionally, the EU's Common Agricultural Policy (CAP) recognizes the natural handicaps of such areas and their association with depopulation and land abandonment through its structural support to 'Less-Favoured Areas' (Regulation 950/97). Fifty-six per cent of the EU utilised agricultural area (UAA) comes within the delimitation of less favoured areas, and of this a substantial amount is classified as mountain areas. Much of this mountain zone is designated Objective 1. Recent French, Austrian and Italian memoranda on mountain agriculture and forestry presented to the European Union Agriculture Council (Council Memorandum, 1996a,b,c) reflect a continuing concern with the economic and social pressures facing mountain farming. However, despite efforts of compensation policies, agricultural incomes in mountain areas remain much lower than lowland farming incomes (Bazin, 1995).

What has been less well recognised in policy development is the environmental impact of agricultural decline. Several recent seminars and reports have examined the topic (Baudry and Bunce, 1991; Beaufoy *et al*., 1994; Baldock *et al*., 1996; Bennett, 1997). Over the previous centuries agriculture has modified the natural environment in many ways. Low-intensity farming, in the form of livestock rearing and traditional cultivation methods, has created semi-natural habitats that now support a wider range of species than might otherwise be found in purely 'natural' climax vegetation. Species-rich grasslands, hay meadows, grazed wetlands and moorland habitats, are all examples of environmental assets associated with, or produced by, low-intensity agricultural land use. Initial estimates reveal that around half of the European network of Natura 2000 sites designated under the Habitats and Species Directive (92/43/EEC) are farmed environments (Bennett, 1997). Areas of high conservation value associated with farming have been created indirectly, rather than purposefully, by certain types of agricultural system. However, in the face of decline in traditional agriculture, these areas may now need to be maintained by conscious management of the practices involved (Bignal and McCracken, 1996). With biological and landscape diversity partially dependent on the farming systems in operation (Beaufoy *et al*., 1994; Pain and Pienkowski, 1996) land abandonment may lead to a corresponding loss in natural capital, although it may sometimes be the case that changes in management practices concerned with stock control and burning practices within low-intensity agricultural systems, may lead to environmental degradation. Baldock *et al*. (1996) have coined the term High Nature Value farming for those types of farming systems associated with valued semi-natural habitats, and the majority of (although not all) such systems occur in remote areas under extensive land use.

In mountain areas, the degree of mechanisation and intensification has been particularly limited and consequently these areas have a high proportion of farming systems which are small-scale and low-intensity and often highly adapted to restrictive or localised conditions (Beaufoy *et al*., 1994). Mountain areas are particularly valuable areas for biodiversity conservation (UNCSD, 1997) and where this resource is threatened by abandonment, the issue needs to be addressed. In its proposals for the reform of rural and agricultural policies, the European Commission (CEC, 1997a) recognises the actual or potential role of mountain farming systems to provide high nature value and to maintain the countryside. Specific examples are given from the southern member states, and from Alpine and Pyrenean valleys. On the international scale the environmental capital associated with mountain areas and the related issues for sustainable development are highlighted in Chapter 13 of Agenda 21 (the 'Mountain Agenda') (UNCED, 1992). The Convention on Biological Diversity, which is a vehicle for the implementation of Chapter 13, recognises the significant role of mountain ecosystems in conserving biological diversity (Gross, 1997). The Habitats and Species Directive (92/43/EEC) identifies the Alpine zone as one of six biogeographical zones and

makes specific reference to important species and habitats (e.g. alpine grasslands) within that zone. It is therefore important that the environmental consequences of agricultural decline in these areas are more fully understood and the implications for management considered. The potential for amelioration of natural capital loss through policies promoting 'environmentally friendly' agriculture is one possibility. The case for agricultural support to such areas could be re-established and made compatible with World Trade Organisation (WTO) constraints by identifying public benefits from traditional farming systems through their maintenance of landscapes, provisions of habitats and embodiment of cultural heritage.

This paper reviews and discusses the evidence of the environmental consequences of agricultural land abandonment and of decline in traditional farming practices in mountain zones. Where these consequences appear to have a negative impact, clearly, management strategies are needed to prevent further loss of nature conservation value. Current and potential policy mechanisms by which such environmental change may be addressed are also discussed. The paper examines current literature on abandonment and draws specifically on the data and expertise from a series of case studies in the mountain areas of Europe. These case studies formed the basis of a report for the European Commission coordinated by Euromontana (1998), which was concerned with environmental pressures and impacts in mountain areas, and their relationship to European agricultural policy. For the purposes of this paper these case studies also provide useful information and insight into the environmental effects of agricultural abandonment in European mountains. (Authors of each case-study are given in Appendix 1).

Description of the study zones

The 24 case-study areas that this paper reviews all conformed to the delimination criteria of mountain zones under EU directive 950/97 (CEC, 1997b). They have a wide geographical distribution (Figure 1), and were selected to be representative of the range of issues currently facing mountain agriculture in these areas, and where information was expected to be reasonably accessible either through existing datasets or the presence of knowledgeable informants. Of these 24 case-studies, one was located in Finland and one in Sweden. Despite their relatively low altitude, these are areas included under 950/97 because of their remoteness and the severity of the natural conditions. Three zones were outside the European Union; two in Switzerland and one in Slovenia. The case studies used a combination of research material including the results of previous studies and consultation with key experts in the fields of agriculture, ecology and policy development. The level of analysis was generally at the scale of the whole zone. Table 1 gives the location of the zones, each classified into one of six climatic groups: Dry Mediterranean, Nordic, Eastern Alps, Western Alps, Oceanic and Central Pyrénées. The zones varied in size between 15 000 and 1 999 000 ha, the boundaries being selected on the basis of internal coherence and data availability.

Table 1 indicates the main forms of land use in the different zones, and these are seen to be contrasting between climatic zones. Arable and cultivated land is a major land use in some Mediterranean zones, whereas in other areas virtually all the land is under agriculture, forestry or unused. Forest cover also varies dramatically between regions with it dominating the Nordic zones and of major importance in many Alpine and Oceanic zones. Due to limitations in data availability and difficulties in definition it was impossible to obtain direct estimates of the areas of 'abandoned' land. However, there are some indications of the scale of the problem in Vallee d'Aoste (zone 16) where it has been estimated that 23% of the agricultural area is threatened with marginalisation and 16% of the area has been totally abandoned (Castelnovi *et al*., 1990).

All zones were affected by the pervasive socio-economic pressures driving agricultural change. Those countries in this study not under the influence of the CAP are affected by WTO regulations, which are directed at removing agricultural trade barriers. Thus the large-scale general pressures which are driving agricultural adaptation may be expected to be broadly similar across all of the case-study zones. Regional and local socio-economic characteristics are also key factors in the process driving change

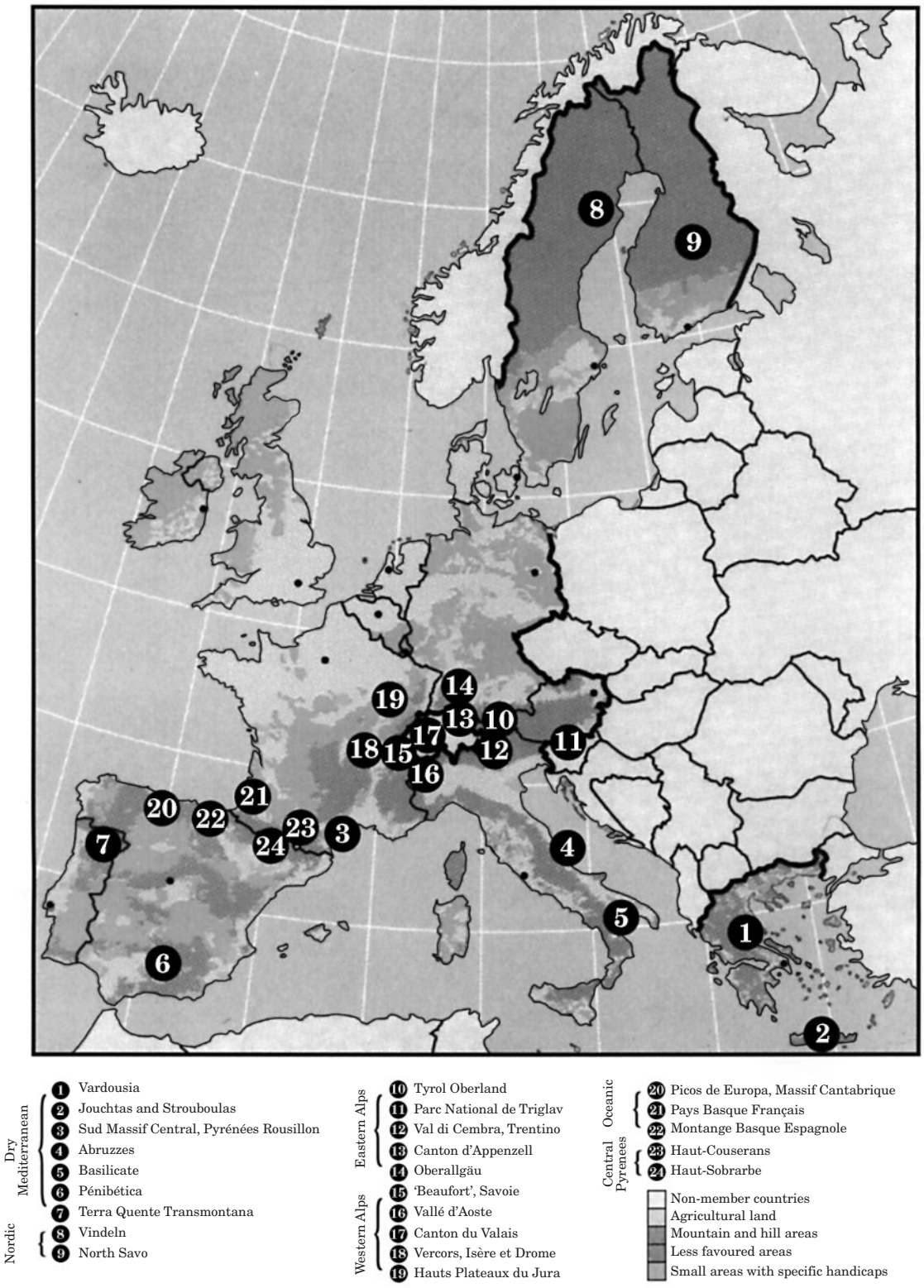

Figure 1. Location of case-study zones.

Table 1. Characteristics of study zones

Climate type	Zone	Name	Country	Zone area (ha)	Altitude range (min-max, m.)	Arable or cultivated land (%)	Grassland/ rangeland (%)	Total UAA (%)[a]	Forest (%)	Unproductive (%)
Dry Mediterranean	1	Vardousia	Greece	56 000	600–2400	15	28	43	52	n/a
	2	Juchtas-Stublas	Crete, Greece	45 000	500–1900	38	54	98	2	n/a
	3	Eastern Pyrenees and Massif Central	France	250 000	300–2800	n/a	n/a	n/a	n/a	n/a
	4	Abruzzo	Italy	190 000	500–3000	n/a	n/a	n/a	n/a	n/a
	5	Basilicata	Italy	201 000	800–2000	n/a	n/a	88	n/a	n/a
	6	Penibetica, Andalousie	Spain	70 000	600–1600	55	7	62	n/a	n/a
	7	Terra Quente, Transmontana	Portugal	340 000	200–1200	39	52	91	9	n/a
Nordic	8	Vindeln	Sweden	265 000	100–500	n/a	n/a	1	78	6
	9	North Savo	Finland	1 999 000	100–200	4	4	8	71	16
Eastern Alps	10	Tyrol Oberland	Austria	335 000	700–3700	1	25	26	52	19
	11	Triglav	Slovenia	84 000	200–2800	n/a	n/a	12	n/a	n/a
	12	Val di Cembra, Trentino	Italy	15 000	200–2500	28	11	39	48	18
	13	Canton D'Appenzell	Switzerland	24 000	500–2500	2	57	59	33	n/a
	14	Oberallgau	Germany	153 000	900–2700	1	46	47	n/a	n/a
Western Alps	15	Beaufort, Savoie	France	389 000	400–3900	n/a	n/a	33	15	51
	16	Vallee d'Aoste	Italy	326 000	300–4700	n/a	n/a	30	24	40
	17	Canton du Valais	Switzerland	522 000	400–4600	6	16	22	22	54
	18	Vercours	France	177 000	200–2300	6	12	18	50	5
	19	Haut-Jura	France	430 000	600–1500	n/a	n/a	n/a	40	n/a
Oceanic	20	Picos de Europa	Spain	180 000	100–2600	n/a	n/a	26	33	15
	21	Pays Basque	France	248 000	100–2000	n/a	n/a	72	n/a	n/a
	22	Pays Basque	Spain	166 000	0–1500	n/a	n/a	30	54	2
Central Pyrenees	23	Haut-Couserans	France	120 000	500–2900	n/a	n/a	n/a	n/a	n/a
	24	Haut-Sobrarbe	Spain	112 000	800–3400	n/a	n/a	n/a	39	n/a

[a]UAA=Utilised Agricultural Area.
n/a, not available.

in mountain areas and will determine the vulnerability and response to external pressures. Table 2 gives some characteristics of the agriculture and economy of the study zones. There is a strong predominance of livestock farming with a tendency for dairy cattle farming in the Alpine and Nordic areas, while the Dry Mediterranean areas have higher concentrations of sheep and goat farming, and permanent crops in the form of vines, almonds and olives. Dairy sheep farming is also common in the Oceanic areas. With the exception of part of zones 2 and 3, which have distinct subzones, farm size is very small. The pattern revealed is one of small-scale farming, often of an extensive nature. The proportion of farmers in the working population varies widely with the Mediterranean and Oceanic regions retaining high levels of agricultural employment compared to Alpine and Nordic regions which have more diverse economies. Common to all areas was the tendency for the farming workforce to be elderly and often without successors although precise statistics were not available in all zones. This implies major structural change in those areas dependent on farming as current farmers retire. The population trend is variable with half of zones experiencing increasing population. However, averages mask depopulation within more rural, isolated parts of some regions while other zones have low population density combined with a declining population.

Abandonment

The socio-economic characteristics of the study zones reveal them to be potentially vulnerable to abandonment either through their high dependence on agricultural employment, or small size of their operations, which may reduce viability and the capacity for adaptation. Indeed, at the regional level of analysis, 21 out of 24 areas cited abandonment of farmland, at a variety of scales and degrees of severity, as one of the main pressures on the environment. Agricultural adjustment may reduce the risk of land abandonment by maintaining the viability of the farm enterprise. Adjustment possibilities include adjustment of farming practices through technical or structural change, on-farm diversification, increased product value-added, or engagement with local and regional labour markets through pluriactivity (Dax *et al*., 1995). To this list may be added alternative land uses including, most recently, the options for agri-environmental activities in the EU under Regulation EEC 2078/92 (CEC, 1992) or equivalent measures in non-EU countries. Agri-environmental measures were applied in 17 of the study zones.

Adjustment is context-dependent because it reflects the opportunities available. Locational factors have been found to be important to the development of on-farm non-agricultural diversification but less relevant for off-farm activities at a sub-regional scale (Edmond *et al*., 1993). Other determining factors in the development of pluriactivity have been found to relate to farm structures and adjustment patterns, characteristics of the farm households, farm succession and the nature of potential labour markets (CEC, 1993). Certainly the incidence of pluriactivity differed between study zones. Some areas with high population densities, indicating the existence of large towns and settlements, and the likelihood of good transport links in the close proximity to farming areas, are found in Appenzell (zone 13) and Pays Basque France (zone 21). However, these areas demonstrated relatively low levels of pluriactivity: 35% and 17%, respectively (Table 2). In contrast, regions of extreme isolation, low current level of inhabitants and decreasing demographic trend such as the mainland Vardousia (zone 1) and Vindeln (zone 8) were found to have high levels of pluriactivity (e.g. 60% Vardousia). The variation found between the study zones highlights the multi-dimensional aspect of pluriactivity determinants.

Continued, or better, integration of farm households into the rural economy may successfully raise incomes and thus support an agricultural presence. However, where redirection of employment is not in the farm vicinity, not seasonally complementary to farm activities, or yields greater unit income, there may be an increased tendency for areas of the farm to become abandoned or intensified in order to accommodate changing demands on labour resources. Thus, whilst abandonment in its extreme form is associated with an inability to adapt farming and land management to social and economic pressures,

Table 2. Agricultural and demographic characteristics of study zones

Climate type	Zone	Predominant farming type	Average Farm size (ha)[a]	Farmers in working population (%)[a]	Population in employment (%)[a]	Population density (inhabitants/km^2)	Direction of population change[a]	% of farmers who are pluriactive[a]
Dry	1	Sheep and goat farming/arable	Very small	50	35	8	Decreasing	60
Mediterranean	2	Vines, olives/sheep and goat farming	2–10 10–100[b]	60	60	59	Stable	20
	3	Dairy sheep and goats/vines/fruit trees	8–60 150–500[b]	21	39	13	Increasing	28
	4	Sheep farming/fodder crops	3–21	23	51	30	Decreasing	Widespread
	5	Arable/dairy sheep farming	Very small	13	51	54	Stable	Low
	6	Olives/irrigated horticulture/goat farming	9	47	40	65	Decreasing	n/a
	7	Olives, vines, almonds/sheep farming	5–12	42	33	27	Decreasing	36
Nordic	8	Dairy farming/cereals	21	6	78	2	Decreasing	Common
	9	Dairy farming/beef farming	25	13	34	14	Increasing	n/a
Eastern Alps	10	Sheep farming/dairy farming	10–30	4	66	26	Increasing	85
	11	Cattle and sheep farming	15	23	44	22	Decreasing	80
	12	Horticulture/vines	Small	13	78	69	Decreasing	60
	13	Dairy and beef farming	12	9	49	224	Increasing	35
	14	Dairy farming	16	10	40	94	Increasing	33
Western Alps	15	Dairy farming	22	3	46	22	Increasing	55
	16	Dairy farming/quality vines	10	7	46	36	Increasing	70
	17	Horticulture/dairy farming	5	4	49	52	Increasing	83
	18	Dairy and beef farming	25	12	45	17	Increasing	62
	19	Dairy farming	n/a	6	54	35	Increasing	30
Oceanic	20	Sheep and cattle farming	2–30	40	45	10	Decreasing	n/a
	21	Dairy sheep farming/beef farming	n/a	31	n/a	21–199[b]	Stable	17
	22	Dairy/meat sheep and cattle/cereals/forestry	34	32	43	13	Stable	26
Central Pyrenees	23	Beef farming	20	17	37	15	Decreasing	33
	24	Sheep and cattle farming	10–50	17	46	3	Stable	n/a

[a]from national records or census statistics.
[b]two distinctive sub-zones.
n/a=not available.

there was evidence that forms of abandonment could occur as part of the process of adaptation itself. In zone 7 (Terra Quente) time required for pluriactivity was found to be contributing to farmers abandoning agriculture. In this region redirection of labour to other employment was also causing changes in management practices usually associated with intensification. Misuse of fertilisers, pesticides and herbicides producing environmental impacts, and unsuitable ploughing techniques causing soil erosion, are the result of lack of time and cost-saving efforts rather than adaptation to more intensive production techniques. In the Tyrol (zone 10) time spent off the farm in pluriactivity left less time for traditional labour intensive activities such as hand mowing with a consequent decline in these practices.

Given the range of contexts and forms of potential adjustment, it was not surprising that abandonment itself took diverse forms. Often it was partial as farmers ceased to use land associated with high costs due to remoteness, difficult access, poor quality land, steep slopes or high labour requirements, or where farmers' age and health prohibited use of land further from the farmstead (Vardousia, zone 1). This could occur within a unified landholding or where remote grazing was carried out on rented or community-owned land (prevalent in the Alpine or Pyrenean regions on the higher pastures). Walther (1986) identifies a much greater probability of abandonment of steep land in the Swiss Alps, rather than land near the settlement. This appeared to be a common pattern in other Alpine countries among the case-study zones. This also occurred where land was deserted from arable cultivation, often due to an inability to mechanise and reduce production costs (Basilicata, zone 5, Haut-Couserans, zone 23 and Haut-Sobrarbe, zone 24). Evidence from the study zones of various adaptation trends are summarised in Figures 2 and 3 where it is evident that different patterns of change were found for different types of farming system. In traditional grassland systems adjustment had frequently occurred, not by abandoning land, but by abandoning traditional practices of land management. This might be represented by spatial changes in grazing practices, for example, on alpine pastures where decline in shepherding has led

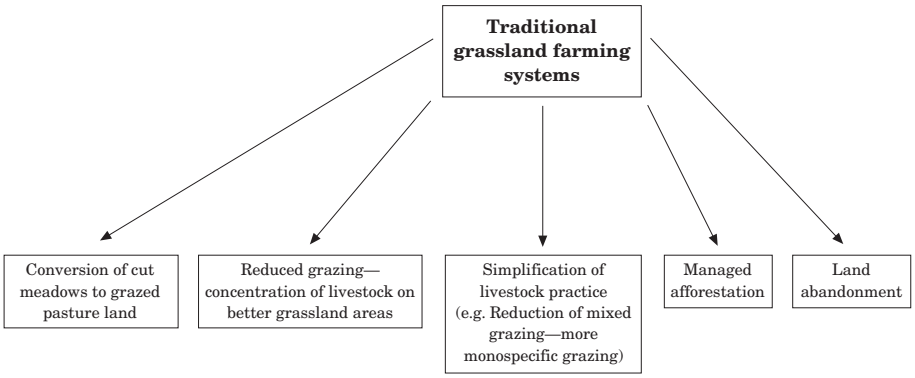

Figure 2. Adaptation in marginal grassland areas.

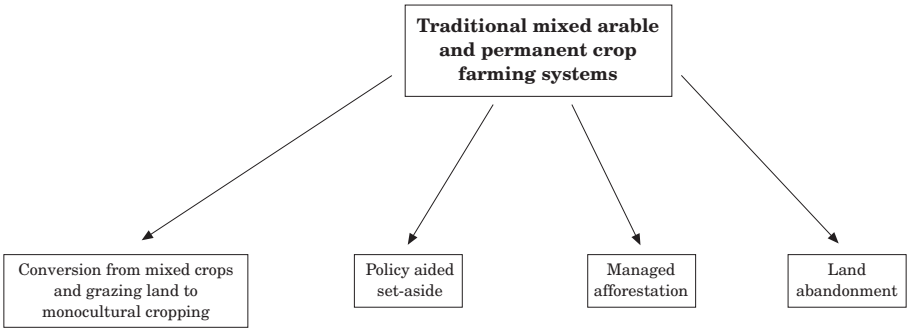

Figure 3. Adaptation in marginal traditional mixed farming.

to localised concentrations of stock around alpine huts, sometimes resulting in overgrazing, or structural changes where meadow management is substituted with permanent pasture. In mixed arable and livestock farming, predominant in the drier Mediterranean areas, changes in management practices generally involved specialization into monocultural cropping. Within both types of farming system there is the potential for loss of environmental quality associated with previous traditional systems. In addition, pressures to maintain farm incomes may result in an intensification of land use associated with abandonment elsewhere on the farm. Intensification tended to be focused on more accessible, higher quality land, typically closer to the farmholding representing a concentration or rationalisation of farming activities at the farm scale. Both the tendency for abandonment and intensification may have associated impacts on the environmental value of farmland and require further analysis of farm level development patterns to obtain more understanding of the interdependency between these polarised management responses (Gibon, 1997; Fillat *et al*., 1998). A typical adjustment scenario was a mixture of abandonment and intensification on different parts of a holding or on land under different tenure arrangements. Such a strategy is not confined to mountain areas but is widespread, for example, in the dehesas of central Spain (Peco *et al*., 1998). Adaptation in the form of intensification is agriculturally successful but, where it involves increased inputs or high stocking rates, it clearly has potential for undesirable impacts on the environment.

Table 3 shows the incidence of abandonment as well as the occurrence of agricultural intensification. Twenty-one out of 24 zones are suffering from some form of abandonment. This tends to be either a reduction of traditional farming practices, generally those associated with livestock practices such as transhumance or hay meadow management, or abandonment in its more extreme form—actual land desertion. Two-thirds of

Table 3. Abandonment of land or of traditional farming practices

Climatic type	Zone	Abandonment of traditional practices	Land abandonment	Biodiversity impacts of abandonment	Landscape impacts of abandonment	Soil and natural hazard impacts of abandonment	Intensification
Dry	1		A	Positive	Positive		
Mediterranean	2			*not relevant*	*not relevant*	*not relevant*	I
	3		A		Negative		
	4	A	A	Negative			
	5		A			Negative	B
	6			*not relevant*	*not relevant*	*not relevant*	I
	7		A	Negative		Negative	B
Nordic	8		A	Negative	Negative		
	9	A	A	Negative	Negative		B
Eastern Alps	10	A		Negative			
	11		A		Negative		B
	12		A		Negative		
	13	A	A	Negative			B
	14			*not relevant*	*not relevant*	*not relevant*	I
Western Alps	15	A	A	Negative	Negative		B
	16	A	A		Negative		B
	17		A	Negative	Negative		B
	18		A	Negative	Negative		B
	19	A	A	Negative	Negative		B
Oceanic	20	A	A		Negative		
	21	A	A		Negative		B
	22	A			Negative		B
Central Pyrenees	23	A	A	Negative	Negative		B
	24	A	A	Negative	Negative	Negative	B

A, abandonment; I, intensification; B, intensification in conjunction with abandonment.

those regions suffering abandonment also demonstrate the phenomenon of better land in the region, or even at the farm level, being more intensively utilised to the extent of producing adverse environmental impacts. Where intensification occurs in conjunction with abandonment within the region, it is denoted by the letter B. In some cases this intensification was an attempt to improve agricultural conditions or structures through national regrouping of land (Spain, zones 20 and 22) or land improvements (Triglav, zone 11 and Valais, zone 17). In other areas it has been through increased stocking rates, often leading to overgrazing on better land, or replacement of mixed farming with monoculture cropping. In three of the 24 zones (Crete, zone 2, Penibetica, zone 6 and Oberallgau, zone 14) abandonment was not found to be a major feature of structural adaptation, and intensification alone has been found to be exerting environmental pressures. Comparison with other zones did not indicate that these zones had uniquely distinguishing characteristics. However, they were characterised by reasonably profitable land use, strong support from Regulations EEC 2078/92 and EEC 950/97, and intensification of production—all of which indicate an element of dynamism.

Environmental consequences of farmland abandonment

The European Commission (CEC, 1997a) groups environmental problems and impacts from agriculture into the following categories: landscape, air pollution and climate change, soil degradation, water pollution and hydrological changes, and effects on biodiversity. The interviews with key actors in the study zones coupled with evidence from policy intervention (e.g. under the Habitats and Birds Directives of the EU) indicated that the environmental impacts of the abandonment of agriculture related mainly to three of these categories. These are impacts on biodiversity (including habitats), landscape and soils. Included in the last category were natural hazards such as the risk of soil erosion and landslides. Risk of wild fires was also a potential natural hazard but these were specific to certain Mediterranean zones.

Beaufoy *et al*. (1994) and Baldock *et al*. (1996) outline a general model of the abandonment process in which a series of changes take place that may involve elements of simplification or modification of traditional practices, afforestation of previous agricultural land or physical abandonment of land. However, our case studies demonstrated that the sequential nature and direction, or scale, of these changes is highly variable and unpredictable due to local circumstances and influences. In the mountain zones where abandonment was taking place, the environmental processes usually involved encroachment of vegetation onto old field sites, loss of grassland areas to scrub and forest, and loss of woodland clearings. These effects were caused by the disuse of land for grazing or for small-scale arable cultivation, the latter generally being on very small farm plots. In some cases, extensification of grazing to a stocking rate inadequate for arresting successional processes was the source of the problem rather than actual desertion. The cessation of traditional meadow mowing practices in the alpine regions was found, in some instances, to be followed by reversion to natural scrub or woodland, or intentional conversion to pasture grass with a consequent loss of meadow flora and fauna. The latter modification is found to produce irreversible changes as steep slopes develop ridges associated with stock paths which make future mowing impossible. The additional consequence of these changes was loss of open space, either in terms of lost agricultural ground, or more usually, as a loss of landscape heterogeneity and mosaic features, which in many cases, represented a loss of cultural landscape.

Biodiversity

Biodiversity refers to the biological variability either at the level of species richness, ecosystem diversity and/or complexity, or genetic variation, and similarly may be assessed at these various levels. Measurement at the ecosystem, habitat or community level is probably the most suitable scale for determining the impacts of agricultural changes. These methods can be relatively rapidly applied and are reasonably well developed (e.g. European Corine habitat classification system) although further work

is needed to investigate the relationships between ecosystem functioning and species diversity (EWGRB, 1997). The identification of habitats, valuable in terms of species richness or rarity, and Red Data Book species within the study zones was thought to be an appropriate method of description compatible with nature conservation objectives. In the light of current concern over global rates of species extinction and the irreversibility of biodiversity loss, further losses of biodiversity, at whatever level, would appear undesirable. A high proportion of the study zones (18 out of 24) contained areas proposed for designation under the Habitats and Species Directive 92/43/EEC, many of which support Red Data Book species. Many of these have been found to relate to farmed environments (Bennett, 1997).

Indicating and interpreting changes in biodiversity is problematic because neither the processes involved nor the evaluation of impacts on environmental values are well understood. Temporal and spatial scales play a part in the environmental impacts of the abandonment process. Preliminary 'models' from Cernusca *et al*. (1996) of the effects on biodiversity in the Alps indicate that there is probably temporal variability in the direction of impact where regeneration of natural vegetation follows the abandonment of meadows and fields. In the early stages of abandonment biodiversity is likely to decrease as aggressive pioneer or dominant species invade or predominate grassland. In the medium term as scrub cover develops the spatial degree of biodiversity may increase but then tends to decline as the woodland canopy closes. This process reveals a dynamic pattern of impacts on biological diversity that is not yet fully understood. Indeed, Peco *et al*. (1998) consider that adequate models of biodiversity and landscape change do not exist. Abandonment also affects the remaining agriculture in that as one plot is abandoned this may make adjacent plots harder to manage through invasion of pests and weeds from the abandoned areas, or encroachment of scrub and shading from forest regeneration. However, there may also be positive effects of these adjacent abandoned areas as refuges for species which contribute to pest control (CEC, 1980).

Table 3 shows that negative biodiversity impacts were thought to be occurring in all but nine of the zones affected by abandonment. In only one region were the biodiversity impacts of abandonment seen as an improvement. The study in Vardousia (zone 1) found that the increase in forest cover had a positive impact by increasing forest species, especially enriching habitats for those species that serve hunting interests. In general species-rich unimproved grasslands and traditionally mown hay meadows are in rapid decline across Europe. This is associated with a reduction in grass cutting in favour of grazing or complete abandonment, but also from agricultural improvement of grassland and conversion of grassland to arable (Beaufoy *et al*., 1994). In mountain areas with existing high forest cover, abandonment which leads to increased woodland may not be desirable in terms of retaining a variety of habitats. This is particularly the case in the mid-altitude areas (mayen) of the alpine regions where regrowth of forest clearings, used in the past *en route* to the mountain pastures, does not favour certain species which are dependent on the combination of habitats currently provided, for example in Vallee d'Aoste (zone 16). Reduction of time spent driving flocks to the higher pastures due to the use of motorised transport for farmers is leading to disuse of these traditional transitional areas. Where species-rich mountain meadows or pastures are replaced with scrub or trees, this may represent a decrease in biodiversity. Haut-Jura (zone 19) contains distinctive woodland meadows that are valuable to black grouse (*Lyrurus tetrix*) and hazel grouse (*Bonasa bonasia*), as well as grazed calcareous grasslands and dry and wet meadows with rich biodiversity. These are currently threatened by regeneration of scrub and undergrowth in the most remote locations, but also by intensification where they occur near farmsteads.

In regions of extensive forest cover relative to agricultural open ground, such as the Scandinavian zones, both abandonment of traditional arable farming in favour of more intensive methods, and land abandonment itself have both resulted in biodiversity losses due to disappearance of habitats. In North Savo (zone 9) there has been a decline in the grey partridge (*Perdix perdix*) and the corncrake (*Crex crex*), as well as several species of butterflies and threatened vascular plants associated with agriculture. The reduction of labour intensive traditional

practices is as valid a threat to biodiversity as physical land abandonment. In the Tyrol (zone 10), there are areas of distinctive and traditional agroforestry where grass is hand-mown under the canopy of mature forests. Although this practice has been supported by local, ecological programmes for the last 20 years, interest and commitment of farmers has recently diminished and these practices are now threatened with abandonment. Conversely, in other areas when more intensively managed land areas such as improved grassland are deserted there may be an increase in species as other colonizers move in (Baldock *et al*., 1996). In the Picos de Europa (zone 20), red partridge (*Alectoris rufa*) and grey partridge (*Perdix perdix*) have lost much of their necessary habitat through loss of hedges, copses and field margins as a result of regrouping of land which was part of an attempt to rationalise small-scale farming in Spain in 1986. It is possible that abandonment of land parcels in this context might reintroduce habitat diversity.

Landscape

Biogeographical characteristics of mountain areas in combination with small-scale and non-intensive agriculture have also lead to landscapes of wide diversity. This has often produced mosaics of landscape features reflecting traditional mixed farming management. Landscape preservation of areas such as these may be increasingly important as landscape becomes more uniform as a result of the globalisation of economic influences and social trends which are bringing European cultural and traditional landscapes under threat (Meeus *et al*., 1990). A criterion on which to evaluate landscape change might be the increase in homogeneity or heterogeneity at various spatial scales (Di Pietro and Balent, 1997). In either case, agricultural abandonment may lead to a change in either direction, depending on the landscape context in which the changes occur. In Vindeln (zone 8), there has been a reduction of arable land of 46% since 1951. Former fields have been transformed into forest land. In an already highly forested area (78%) this represents increasing rarity of open space. This was perceived as symptomatic of increasing rural decline in the area and thought to have a depressing effect on the remaining inhabitants. These perceptions can contribute to decline and out-migration of these areas. This type of self-perpetuating cycle was also found to be the case in Lozère, France (Giuheneuf *et al*., 1996) and Canada (Smith *et al*., 1991).

Many landscapes developed over long time spans are threatened by abandonment. In the Finnish zone, national heritage landscapes created by traditional slash and burn cultivation carried out in previous centuries are suffering from decline which may worsen in the next decade as further structural change occurs driven by the fall in net agricultural income of 14% in Finland since EU accession. Equally traditional, although of a different type, highly distinctive landscapes have developed in Alpine and Pyrenean regions through centuries of agricultural land use. The areas of most obvious landscape change due to abandonment, in this setting, have been found to be the middle mountain slopes (Vallee d'Aoste zone 16, Beaufort zone 15, Appenzell zone 13, Haut-Couserans, zone 23, Haut-Sobrarbe, zone 24). This has resulted, not only in loss of open pastures and clearings as scrub and forest regenerate, but also a loss of characteristic decentralised farm settlements as farms amalgamate or are allowed to run down. In the Pyrénées similar changes may occur as traditional transhumance declines (Pays Basque France, zone 21) and where there is scrub invasion on underused land (Pays Basque Spain, zone 22). In contrast, in the Mediterranean zones tree growth was perceived as a beneficial change, in Vardousia (zone 1) by enhancing landscape, and in Terra Quente (zone 7) to avoid the dangers of soil erosion related to abandonment. Nevertheless, account must be taken of the use of more fire resistant species, management of undergrowth to avoid increasing fire risk and the stages of planting and harvesting which can increase soil erosion if mismanaged. There is, however, a consideration to be applied to all landscape assessment: landscape preferences are strongly affected by cultural and social interpretation of the physical changes (Guillot *et al*., 1998).

Soils and natural hazards

In the case of natural hazards the same pattern of temporal variability can be seen.

Slope stability is of particular importance in the Alpine regions with landslides and avalanches threatening human settlements, and soil erosion having detrimental effects on localised agricultural land and natural habitats. Neglect of mown or grazed alpine pastures leads to the build-up of biomass of vegetation which in the winter months forms a mulch which greatly increases the risk of snow-slides, avalanches and associated landslips (Cernusca *et al*., 1996). In the short-term, abandonment thus poses an increased risk of natural hazard yet over longer periods, as scrub and trees encroach, this risk lessens considerably and areas may well have greater slope stability than under previous agricultural usage. Fire hazard in the drier Mediterranean regions, likewise, may increase initially as coarse and dry grasses follow the abandonment of arable or pasture areas (Gonzalez Bernaldez, 1991). As tree cover follows and influences ground vegetation, the risk of fire may decrease although this process may involve time periods in the order of 50 years or more. Not only does fire pose a threat to natural and agricultural flora and fauna but interacts with erosion processes in dry climatic zones. When fire interrupts the successional process then a protective scrub cover isn't formed and sheet wash erosion may result in loss of productive top soil (Garcia-Ruiz *et al*., 1991). This pattern of soil and vegetation deterioration can ultimately lead to irreversible desertification in arid zones such as dry Mediterranean areas. The increased risk of natural hazards as a result of abandonment of agricultural practices or of land desertion emphasises that active management of abandonment may be beneficial in maintaining or reinstating environmental stability (Fernandez Ales, 1991).

Mismanagement of the soil can also result in significantly increased rates of soil erosion and in arid climates may lead to desertification, a process whereby soil becomes irreversibly degraded with permanent loss of vegetation and productivity. Protection of soil from erosion, and in come cases desertification, is a serious concern in dry Mediterranean areas where soils are thin and fragile and where vegetal cover tends to be sparse. Abandonment may increase the likelihood of soil loss when terraces are unmaintained (Trentino, zone 12). In some of the dry Mediterranean study zones (Terra Quente, zone 7, Basilicata, zone 5) the impacts of abandonment were strongly accelerating erosion of the soil. The Portuguese zone is nationally classified as a high-risk desertification area, and therefore is particularly vulnerable to the effects of soil loss. In all climates the retention of vegetative cover on the soil is an important factor for maintaining soil stability, although in arid zones this is complicated with the increased fire risk associated with growth of coarse and dry grasses following abandonment.

Contextual interpretation of abandonment

Whilst increased risk of natural hazards is unequivocally undesirable as a consequence of abandonment, both because of its impact on natural resources and the risk to inhabitants, the interpretation of biodiversity and landscape changes is less self-evident. The context in which land-use change occurs will be relevant; hence the existing range and density of species or landscape features will, in part, determine the interpretation of change. Abandonment may increase local landscape homogeneity but add to heterogeneity at a regional level, thus increasing the landscape grain size within a region, as productive and non-productive areas become more differentiated (Baudry and Bunce, 1991). Likewise, temporal and spatial factors play a part in the successional process. At a field level, biodiversity may decline in the short-term as aggressive species colonize but may increase over longer time periods as ecological complexity increases (Baudry and Bunce, 1991).

The process of adaptation to socio-economic pressures was, in the majority of cases, predominantly that of an abandonment/intensification phenomenon, with abandonment or intensification alone being features of a minority of the zones. At a regional level, the impacts appear to be similar in that the direction of change is perceived as environmentally negative, with the exception of Vardousia (zone 1). The western Alps and Nordic zones show a consistency of biodiversity and landscape impacts whereas other areas demonstrate a more variable pattern. It is of interest to see whether contextual factors, such as the existing land cover, can

explain these differences. Table 1 gives the percentages of different land-cover types in each zone. Although data are incomplete, they provide an interesting regional context in which to assess the effects of abandonment and go some way to explaining differences between study zones. Comparing Tables 1 and 3 reveals that all but one of those zones citing negative landscape impacts have an UAA of less than 40%, usually with an associated high percentage of forest cover. In mountain regions, especially the Alps, much of the land is rock or other completely unproductive land leaving an even lower proportion of the land area available for agriculture. Low UAA figures correspond to those zones which cite negative landscape impacts resulting from land abandonment. The Tyrol (zone 10), where abandonment relates to the cessation of traditional practices rather than extensive physical land abandonment, does not demonstrate negative landscape impacts. It is interesting that in other abandoned zones with a high UAA (Basilicata, zone 5, and Terra Quente, zone 7) there has been no identification of negative landscape impacts. In these cases an increase in woodland could be environmentally enhancing by increasing the variety of habitat and adding to landscape heterogeneity. Thus, at a regional level, similar effects of the abandonment process may depend on contextual factors such as existing land cover patterns as to whether they are interpreted as undesirable or not in terms of these defined parameters. Farina (1991) suggests the landscape meso-scale (farmland communities) is the appropriate one on which to manage and maintain landscape mosaic due to the different historical utilisation of land and of the differences in the process of biophysical change following abandonment.

Regulation EEC 2078/92 and equivalent policy measures

Mountain areas in the EU receive support for agriculture and rural development from a range of policy measures. Whilst they undoubtedly have an important influence on the extent and location of land abandonment, a full examination of their influence is beyond the scope of this article. We concentrate on the main EU policy measure for modifying the environmental impacts of farming (Regulation 2078/92). This is applied at a national or regional level in most countries although the extent and remit varies considerably. Although it has a broad scope for environmental protection and enhancement, it can be applied specifically to problems of abandonment through elements of the aid scheme such as: use of farming practices compatible with environmental protection, maintenance of landscape, rearing endangered animals (Article 2.1.d), up-keep of abandoned land (Article 2.1.e), 20 year set-aside (Article 2.1.f), organic farming (Article 2.1.a) and training and demonstration for farmers (Article 2.2.).

Despite only recent implementation in most countries, it is possible to make some preliminary assessment of the impact of 2078/92 in ameliorating the environmental consequences of land abandonment and the loss of traditional farming practices. Information on the application and effectiveness of the policy are analysed and summarised in Table 4. Agri-environment policy has been applied in quite different ways by different Member States (Whitby, 1996) and it was therefore thought to be appropriate to classify zones by country, rather than climatic zone, in this analysis. The most relevant national programmes are identified for each zone affected by abandonment where 2078/92 has been applied. The effectiveness of these programmes is assessed through factors that create obstacles or incentives to uptake, and the programmes' relevance to environmental consequences of abandonment. The factors that exert a negative influence on uptake of the measure, or on the environmental parameters, are marked by bold, italic type and blank sections denote unavailable information.

Uptake of programmes also varies considerably across the zones. Some payment schemes exhibited a high degree of adaptation to regional and local environmental priorities, such as the maintenance of mown meadows and support for other traditional practices. Effectiveness in abating the identified impacts of abandonment tends to be positive, although this relates rather more to the potential of policy programmes, as there were few cases where hard evidence of conservation benefits of the policy could be provided.

Table 4. Application and efficiency of regulation 2078/92 in zones affected by abandonment

Country	Zone suffering abandonment	2078/92 Applied	Main types of programme relevant	Obstacles (bold type)/ incentives to uptake of specific programmes	General obstacles (bold type)/incentives to uptake of 2078	Effectiveness in regard to abandonment issues (biodiversity, landscape and soil erosion)
FRANCE	3 21 23	Yes	Grassland premium (prime a l'hèrbe)	• Solved problems of collective land • Requirements easily met • ***Payment too low*** • ***Indirect encouragement to increase farm size***	• ***Complicated administration of projects***	• Helps maintain open landscape through farm support
	15 18	Yes	Clearance of overgrown land and maintenance of pasture	• ***Payments too low to fully cover costs and effort*** • ***Lack of available labour*** • Highly targeted to declining areas	• ***Lack of precise ecological management knowledge***	• Limited help in maintaining open landscape
	19		Late meadow mowing and pasture maintenance	• Payments for these programmes are complementary with each other	• Improves environmental awareness of farmers	• Helps maintain meadow and grassland biodiversity
			Grassland premium (prime a l'hèrbe)	• Requirements easily met		• Helps maintain open landscape through farm support
ITALY	5	Yes	20 year set-aside for cereals	• ***Rigorous requirements hard to meet***	• ***Maladministration-long time lag in receiving funding***	• ***Increases erosion as soil is left bare***
	16	Yes	'Alpiculture' Support for traditional alpine pasturing	• Requirements easily met		• Funding of traditional practices helps maintain alpine pastures
			Grassland premium with manure management	• High levels of payments		• Helps maintain slope pastures
			Traditional arboriculture			

(*Continued overleaf*)

Table 4. (*Continued*)

Country	Zone suffering abandonment	2078/92 Applied	Main types of programme relevant	Obstacles (bold type)/ incentives to uptake of specific programmes	General obstacles (bold type)/incentives to uptake of 2078	Effectiveness in regard to abandonment issues (biodiversity, landscape and soil erosion)
SPAIN	20	Yes	Organic agriculture	• ***Capital investment needed to fence areas*** • ***Fragmented farm plots*** • Requirements easily met		• Helps maintains traditional agricultural practices, conserving biodiversity and landscape
			Clearance of over-grown land			• Helps maintain open landscape
			Set side	• ***Inappropriate to zone with few intensification problems***		
	22	Yes	Conservation of endangered breeds		• ***Lack of diffusion of 2078***	• Helps maintain traditional livestock species which are beneficial to the zone
			Conservation of mountain pastures		• ***Lack of interest by farmers***	• Helps to maintain open landscape and traditional pastures
SWITZERLAND	13 17	Similar measures	Environmentally sensitive integrated production		• High support payments	• Extensification aspect requires more land and may help reuse abandoned areas
			Organic agriculture	• ***The whole farm needs to be in scheme***	• ***Inappropriate to zone with specialised cultivation***	• Improves biodiversity
			Free range cattle			• Extensification aspect requires more land and may help reuse abandoned areas
PORTUGAL	7	Yes	Traditional olive growing	• Complementarity with CAP payments		
			Traditional almond growing	• ***Payments too low to compensate for loss of CAP support***		
			Organic agriculture	• Requirements easily met		

Table 4. (*Continued*)

SWEDEN	8	Yes	Preservation of open arable landscape		• High levels of payment	• Helps maintain open landscape
			Preservation of species-rich hay meadows and pastures		• ***Complicated and overlapping administration***	
			Organic agriculture		• ***Contradictory support with CAP***	• Maintains open landscape due to more land used
FINLAND	9	Yes	General environmental protection and enhancement programme	• High levels of payments • Replaces previous support		• Maintains open landscape by income support
			Organic agriculture			
AUSTRIA	10	Yes	OPUL—Traditional hay mowing	• ***Premium may be too low to compensate for effort involved***	• High general levels of payment • Replaces previous support	• Helps maintain meadow species
			Organic agriculture	• ***Some capital investment needed*** • ***Insufficient organic markets*** • Requirements easily met		• Helps maintains traditional agricultural practices, conserving biodiversity and landscape
SLOVENIA	11	Similar measures	Manual mowing of mountain meadows			• Helps maintain open landscape and meadow species

Bold, italic type indicates obstackes to programme update.

When uptake is low or minimal, the environmental benefits are likely to be small in terms of areal impact, even if the measure is effective in meeting objectives. Where uptake is at higher levels, the environmental gains will depend on the objectives of the specific measure and its ability to deliver these. Where the measure is broad-based or horizontally applied, such as the grassland premium in France, General Agricultural Environment Protection Scheme, Finland and OPUL programme, Austria, the aid is relatively untargeted and may not provide great direct environmental benefits. Its principal impact is as income support which may have indirect benefits through the maintenance of a farmed landscape. In other cases, where payments are more specifically directed and have more demanding requirements, for example organic cultivation or support for traditional alpine pastoral practices, greater environmental protection or enhancement can be expected. However, in many of the zones (zones 7, 10, 16 and 20) the current farming practices are so similar to those required by the programmes, that these farming systems appear to be well suited to meeting the environmental objectives of 2078/92 programmes at the same time as allowing the possibility of enhancing farm income. Although this may not bring any net environmental gains, it is a means of maintaining the current environmental assets produced by low intensity farming while lessening the likelihood of farm adaptation and the possibility of further intensification.

In some instances policy has been well conceived. Traditional olive growing in zone 7, Terra Quente has had high uptake due to the complementarity of the measure with mainstream CAP support and has helped avert either abandonment or intensification of these practices. Likewise, zone 19, Haut-Jura, France has well-integrated programmes that allow some degree of accumulation of payments, allowing an increase of farm income, thus encouraging continued farming in the zone. Despite these positive elements there remain severe obstacles to successful implementation of 2078/92. The shortage of labour in many mountain zones is often an obstacle to policy implementation particularly for those practices or requirements that are particularly labour intensive such as scrub clearance. This cannot be dealt with by agri-environmental policy alone, but requires integration with other sectors. Elsewhere, (for example, Picos de Europa, zone 20), there was a failure to account for capital investment requirements in the form of fencing in order to meet the requirements of programmes such as organic livestock rearing. In many cases payments for agri-environment practices, although raising some interest, were generally found to be unattractive to farmers because of the high opportunity cost incurred in the loss of other CAP payments. The lack of well-defined environmental objectives, and lack of awareness by farmers of those objectives, did not encourage a positive response to policy uptake. It has been established that, where farmers are facing exposure to environmental policies for the first time, their understanding and sympathy for the environmental objectives of policy may be very limited (Beopoulos and Louloudis, 1997).

Discussion

Abandonment of agricultural land and of traditional framing practices is continuing to occur in the mountain areas of Europe. While the socio-economic driving forces are ubiquitous, the environmental impacts are spatially diverse. This diversity reflects not only variation in the type of abandonment and whether it is associated with intensification, but also variation between regions in the characteristics of the environment and its sensitivity to changes in land use. In many cases there is clear evidence of negative effects of abandonment across the spectrum of impacts investigated. However, environmental indicators are not well developed for biodiversity and landscape change, nor are interpretations of change always unambiguously positive or negative. Impacts on biodiversity and landscape are especially difficult to interpret and effects may be compounded by the choice of measurement. For example, if diversity is taken as a single criterion, measured for example by a Shannon index (Pielou, 1977), then abandonment may initially increase habitat and landscape diversity as abundance of components increases, but progressive abandonment would ultimately reduce diversity as certain elements dominate the habitat or landscape. However,

use of a natural capital measure for valuing environmental assets could lead to the conclusion that abandonment of any high nature value farming land would result in a depreciation of the capital stock.

In responding to land abandonment two different roles for policy can be proposed. The first concentrates on the prevention of abandonment. Sectoral and structural measures reduce the underlying pressures that lead to abandonment although it is well established that they can also encourage less labour intensive farming and the uptake of technology, both of which may lead to some change in land management. In contrast to current targeting criteria for structural measures, which relate to socioeconomic disadvantage, adopting a firmer environmental perspective would call for the spatial targeting to incorporate the environmental impacts. Here the concept of environment would include the cultural and heritage capital at risk. This would develop the case made by Baldock (1998) for protecting high nature value farming, by extending the concept of environment to include not only all ecosystem services but the services provided by cultural and heritage capital.

However, structural policy at regional level is a blunt instrument for addressing environmental issues. Agricultural policy, intrinsically linked to land management, may offer a more appropriate framework as well as allowing for the necessary farm-level measures required for the reduction of abandonment. However, it was clear from the study that different CAP measures often transmitted conflicting signals to farmers—some stimulating agricultural change and the adoption of technology whilst others were directed at protecting the environment from change. Some scepticism has been expressed about the possible environmental benefits of 2078/92 due to this lack of integration with other CAP measures (Brouwer and van Berkum, 1996) and the small proportion of the European agricultural budget that this measure receives in comparison to other agricultural policy measures (Bauer, 1997). The continuing degradation of environmental capital in many of the study zones indicates that current policy measures are not entirely successful in ameliorating damage. In some areas agri-environmental measures have not been applied or give limited additionality. Nevertheless, the present study found that many of the 2078/92 programme elements were relevant to the issue of abandonment and should produce environmental benefits if various obstacles to low uptake can be resolved. The new Rural Development Regulation (1257/1999, CEC, 1999) provides a framework for action in less-favoured areas (including mountain areas). Compensation may be paid to ensure continued agricultural land use, thereby contributing to the maintenance of viable rural communities; to maintain the countryside and to maintain sustainable farming. There are also measures to support forestry and specifically sustainable forest management, the maintenance of forest resources and the extension of woodlands. The regulation provides an opportunity to address many of the abandonment issues raised in this paper. However, with Member states contributing 50% of the finance, prioritisation will be essential. There will also be a need for careful local and regional application and adaptation of measures. The climatic and contextual diversity of areas shown to be experiencing abandonment is such that strategies effective in one area may not necessarily produce environmental benefits in another.

A second and complementary approach to abandonment would concentrate, not on measures to prevent abandonment, but on measures to manage abandoned land. Given that land will continue to be abandoned, resulting in loss of environmental capital which in some cases may represent irreversible changes, management of such land to minimise environmental damage remains an option. This might be in terms of managing successional processes to encourage certain outcomes that contain greater conservation value than might otherwise be the result, or which lessen the likelihood of an increase in natural hazards. For example, introduction of tree species on abandoned areas in the dry Mediterranean could help prevent erosional problems, and reduce fire hazard associated with scrub stages. However, this type of management needs sensitive application and must include reasonably fine-scale heterogeneity in order to provide conservation benefits (Fernandez Ales, 1991)—a radically different approach from current afforestation programmes. This is relatively new territory. Some measures under 2078/92

(e.g. long-term set-aside) are beginning to address the issue, although experience in the dry Mediterranean mountains (Basilicata, zone 5) shows that these must be carefully targeted and appropriately applied if measures are to provide environmental value. The scale of the problem in relation to currently abandoned land and areas identified as at risk suggests that highly targeted programmes to reduce natural hazards, to protect soil and water resources, and to protect or enhance biodiversity will be required. Management of abandoned land requires incentive structures and this will pose significant challenges for future policy design in order to produce environmental benefits without incurring excessive costs. One clear external benefit is the provision of employment and income to existing farmers in such land management programmes, although the success of this approach would also be influenced by policy in other sectors which affects the wider context of socio-economic and agricultural conditions in mountain areas.

Abandonment of agricultural land and traditional farming practices is evident across a wide range of mountain areas in Europe. Whilst assessment of the environmental consequences is not straightforward due to measurement, interpretative and contextual factors, some loss of environmental and nature conservation value is likely to follow these changes. Management strategies and policies to ameliorate or prevent further decline in environmental value need to be developed and successfully applied to offset the impact of continuing agricultural abandonment.

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Appendix 1

Authors of 24 case-studies

Zone number	Zone name	Authors of case-studies
1	Vardousia	Professor Nikolaos Stamou and Vaios Blioumis, Aristotle University of Thessaloniki, Greece Dimitri Katsaros, Insititute of Mountainous Rural Economics, Karpenisi, Greece
2	Juchtas-Stublas Mountains	Professor Nikolaos Stamou, Aristotle University of Thessaloniki, Greece Professor Athanasios Christodoulou, Aristotle University of Thessaloniki, Greece
3	Eastern Pyrennees and Massif Central	Jean-Paul Chassany, INRA ESR Montpellier, France Marc Dimanche, SIME Montpellier, France Bernard Roux, Parc National des Cévennes, INAPG Paris, France
4	Abruzzo	Dr Manuela Cozzi, Associazione Regionale Produttori Ovi-Caprini, Italy
5	Basilicata	Professor Francesco Contó, Centro Istruzione Assistenza Technica Agricola, Italy
6	Penebitica, Andalousie	Dr Ruiz Aviles, Junta de Andalucia, Centro de Investigación y Desarrollo Agriario, Cordoba, Spain
7	Terre Quente, Transmontana	Livia Madureira, Departamento de Economia e Sociologia, Universidade de Trás-os-Montes e Alto Douro, Portugal
8	Vindeln	Ulf Wiberg and Monica Johansson, Department of Social and Economic Geography, Umea University, Umea, Sweden Erik Sondell, Centre for Regional Science, Umea University, Umea, Sweden
9	North Savo	John Sumelius, Stefan Bäckman and Asko Miettinen, Agricultural Economic Research Institute, Department of Economics, University of Helsinki, Finland
10	Tyrol Oberland	Thomas Dax and Georg Wiesinger, Bundesanstalt fur Bergbauernfragen (BABF), Vienna, Austria
11	Triglav	Tomaz Cunder, Kmetijski Institut Slovenije, Ljubljana, Slovenia Marija Markes, Triglave National Park, Bled, Slovenia
12	Val di Cembra, Trentino	Dr G. Nicolini and Elena Piutti, Centro di Ecologia Alplna, Viote del Monte Bondone, Trento, Italy
13	Canton D'Appenzell	Erwin Stucki, Institut d'Economie Rurale de Zurich, Switzerland J. Wyder and P. de Giorgi, Groupement Suisse pour les régions de montagne (SAB), Brugg, Switzerland Gabriela Eschler, ETH-IAW, Zurich, Switzerland
14	Oberallgäu	Michael Köbler, Federal Institute for less-favoured and mountainous areas and Chair of Agricultural Economics, Technical University of Munich, Germany
15	Beaufort, Savoie	Phillipe Fleury and Didier Curtenaz, GIS Alpes du Nord, SUACI Montagne, Chambéry, France
16	Vallee d'Aoste	Claude Duverney, Mr. Bassignana, C. Francesia and C. Jacquemod, Institut Agricole Regional, Aoste, Italy
17	Canton du Valais	Pierre Rognon and Erwin Stucki, Institut d'Economie Rurale de Zurich, Switzerland
18	Vercors	Phillipe Charretton, Cemagref, Grenoble Division, E.P.M., France
19	Haut-Jura	Laurent Barbut, ASCA, Paris, France
20	Picos de Europa	Amaya Arbulu and Mario Saenz de Buruaga, Consultora de Recursos Naturales S.L. Spain
21	Pays Basque France	O. Clément, INRA, Station d'hydrobiologie, St. Pée-sur-Nivelle, France
22	Pays Basque Spain	J. Gutierrez Lazpita and Clara Icaran Souville, IKT, Arkaute, Vitoria-Gasteiz, Spain Eugenio Ruiz Urrestarazu, Universidad del Pais Vasco, Spain
23	Haut-Couserans	Annick Gibon, INRA, Unité de Recherches sur les Systémes Agraires et le Developpement, Castanet Tolosan, France
24	Haut-Sobrarbe	J.P. Martinez-Rica and F. Fillat, Instituto Pirenaico de Ecologia (C.S.I.C.), Saragosse, Spain