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Alpine farming in Austria, for nature, culture or economic need?

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Abstract

The paper explores the importance of alpine farming in Austria. Alpine landscapes have major shares of pristine landscapes but are also transformed by man into cultural landscapes. Alpine farming systems play an important role in sustaining biodiversity as the traditional land management is creating heterogeneity and niches which are habitats for many different species adapted to this situation. Climate change as well as global and European trends in agricultural policy leads to landscape changes, which have to be assessed in terms of ecological, social and economic impacts. Nature value, fragmentation and hemerobiotic state of landscapes are presented as indicators for a landscape assessment on different scales. Nature value reflects the relative importance of landscape for sustaining biodiversity and represents a tool for the formulation of further development strategies on the landscape-type scale applicable for landscape planning. The fragmentation of landscapes, as a major threat to biodiversity, is analysed on the landscape-type level by using the indicators 'Influence by major traffic networks' and 'Remoteness'. Examples for alpine landscapes are given and the link to the occurrence of large predatory mammals is shown. The hemerobiotic state is used as an indicator at the landscape level to measure the human impact on habitats and landscape. It may play a central role in environmental reporting to politicians and to the public. Samples of the landscape structure and the distribution patterns of human influence on managed alpine landscapes are given.
Keywords: alpine landscapes; cultural landscape; landscape assessment; nature value; fragmentation; hemerobiotic state; biodiversity

Introduction

Due to its geographical position in the heart of Europe, Austria encompasses a great variety of different landscape types (Grabherr 1994). Whereas wilderness areas remained only in some remote regions of the high Alps and along the Danube river, most of its forelands and valleys have been subjected to continuous human influence since the Neolithic period (Bätzing 2003). Today, about half of Austria's territory can be described as open agricultural landscapes, shaped by different farming systems. Especially in the alpine regions traditional mountain peasantry based on dairy farming can be found, whereas crop-producing farms with large consolidated field blocks are

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prevailing in the lowlands of Eastern Austria (Wrbka and Fink 1997; Wrbka et al. 2002). Nevertheless, in a European or global perspective both types of farming systems can be regarded as small-scale with an average size of agriculturally used land of about 15 hectares (Binder and Pfingstner 1988; Sandgruber 2002). Therefore, many Austrian farmers are facing an enormous economic pressure caused by recent socio-economic changes, like the transition process in neighbouring countries and the membership of the European Union since 1995 (Ortner et al. 1996). On the other hand there is a growing awareness of the high non-market values produced by these small family farms (Pevetz 1998). Agricultural policy in Austria is therefore focussing on agro-environmental programmes, which should encourage environmentally friendly farming systems. Nevertheless, it seems dubious whether the 'Austrian way' of spending large sums of money for keeping the farmers on their land is an economically viable solution. Especially ecologists show growing concern that the subsidy system could fail to have the intended positive effects on the state of the environment and biodiversity (Abensberg-Traun et al. in press).

Nature values in the Austrian Alps

From a nature-conservation point of view, it was often stated that small-scale agriculture, especially in the alpine region, is contributing a lot to the maintenance of high biodiversity values (Grabherr 1994). But, if we assess conservation efforts by measuring the ecological integrity of ecosystems, we might come to the conclusion that large wilderness areas in remote parts of our country are of greater importance.

Looking at the contribution of different landscapes to the nature value of Austria clear patterns can be shown. The nature value reflects the number and quality of biotopes present in the different landscapes and their relative importance for preserving biodiversity, and gives the basis for formulating further development strategies – conservation or restoration. The map of the nature value of Austrian landscapes (see Figure 1) results from an expert-knowledge-based assessment procedure linking several evaluation criteria like age, persistence, integrity and diversity (Wrbka et al. in press-b), using a dichotomous decision tree. The assessment was based on landscape types. Five categories of nature value were distinguished (very high, high, medium, low and very low). The geographical database was drawn from the classification of Austrian cultural landscapes (Wrbka and Fink 1997; Wrbka et al. 2002). Landscapes with a contribution to high nature value are concentrated in four major ecoregions of Austria (see Figure 1). The first two, namely the central high Alps and the eastern low Alps, are part of the alpine region, whereas the latter two, namely the Hercynian Upland and the Pannonian Lowland, are situated on the northern and the eastern boarder of Austria.

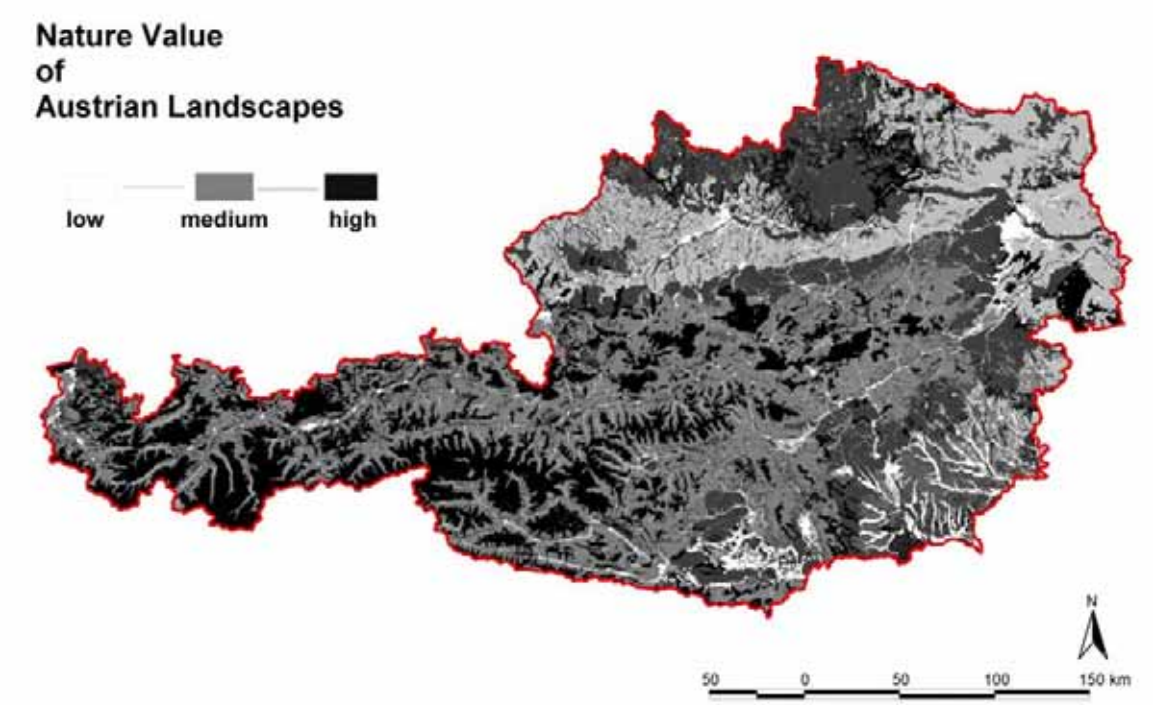

Figure 1. Nature value of Austrians landscapes (Wrbka et al. in press-b): low (light-grey shades) means a low relative importance for preserving biodiversity as only small parts of natural and semi-natural biotopes are left in the landscape, and high (dark-grey shades to black) means a high relative importance for the conservation of biodiversity, which means that distinct areas of natural and semi-natural biotopes are present. The map is based on an expert-knowledge assessment procedure of the Austrian cultural landscapes

The share of five main landscape categories with different dominant land-use systems and nature values for the whole Austrian territory is given in Table 1. Almost one third of the Austrian landscapes show a very high to high nature value, meaning that they have major shares of habitats with natural or close to natural status. Forty-five per cent are assessed as a medium nature value and about one fifth of the territory shows a low or very low relative importance for the national biodiversity. Apart from the geographical distribution of areas with high nature value, it is interesting to investigate which types of landscape are contributing to it. A closer look reveals that not only alpine or forested landscapes can be found in areas with high nature value. Remarkably, also 17% of Austria's agricultural landscapes are found in this group.

Table 1. Distribution of nature value within the main landscape categories of Austria's cultural landscapes. Values indicate the percentage (%) of Austria's territory

	alpine and sub-alpine landscapes	*forested landscapes*	*agricultural landscapes*	*urbanized landscapes*	*total*
Very high nature value	13	2	2	-	17
High nature value	-	1	15	-	16
Medium nature value	3	33	9	-	45
Low nature value	-	-	20	1	21
Very low nature value	-	-	-	1	1
Total	16	36	46	2	100

The results of the assessment of the nature value of Austria's cultural landscapes imply that successful nature conservation should not only focus on the preservation of wilderness areas, but also has to integrate efforts of sustainable land-use planning and land-use policy in agricultural landscapes. A study of the dynamics of agricultural landscapes and the driving forces behind them shows the importance of nature-conservation efforts in agricultural landscapes. In mountainous areas of Austria agriculture contributes to high nature values as well as to high aesthetic values. By managing the land in a more or less traditional way, a high diversity of different habitats is created and maintained. As tourism is an important economic factor in Austria, it is obvious that the stewardship of mountain farmers for a diverse and beautiful landscape is of great importance.

The Alps – Remote and unfragmented landscapes?

Major trends of international and global driving forces like, e.g., global transportation of goods, will not and do not stop at the border of the Alps. The effects of these drivers on these very sensitive landscapes are tremendous. Pressures like habitat fragmentation have been described as a major threat to the biodiversity of natural and semi-natural ecosystems on a global as well as on a local scale (Forman 2000; Forman and Sperling 2003; Noss 2003; Switalski et al. 2004). Several indicators have been used to describe the extent of fragmentation for landscapes (Jaeger 2000). The extent of fragmentation on the landscape-type level was analysed for Austria's cultural landscapes (Wrbka et al. 2001) and showed characteristic patterns. The indicators 'Influence by traffic networks' (also termed fragmentation) and 'Remoteness' were calculated on the basis of the road network. Figure 2 shows the result of the assessment of the influence by main traffic infrastructure. It is obvious that mountainous areas of Austria are less fragmented than the lowlands in the East and the uplands in the North. But a closer look reveals that especially the valleys and basins of the Alps suffer from a severe fragmentation, because geomorphological constraints by the mountainous terrain lead to a concentration of the (major) traffic lines – partly of significant importance as transit routes both from North to South and from East to West – in those areas. The fragmentation is concentrated in small areas like river valleys, where permanent settlements are concentrated. In total the lowlands show a higher traffic impact than the alpine region, but fragmentation is more evenly distributed and widespread.

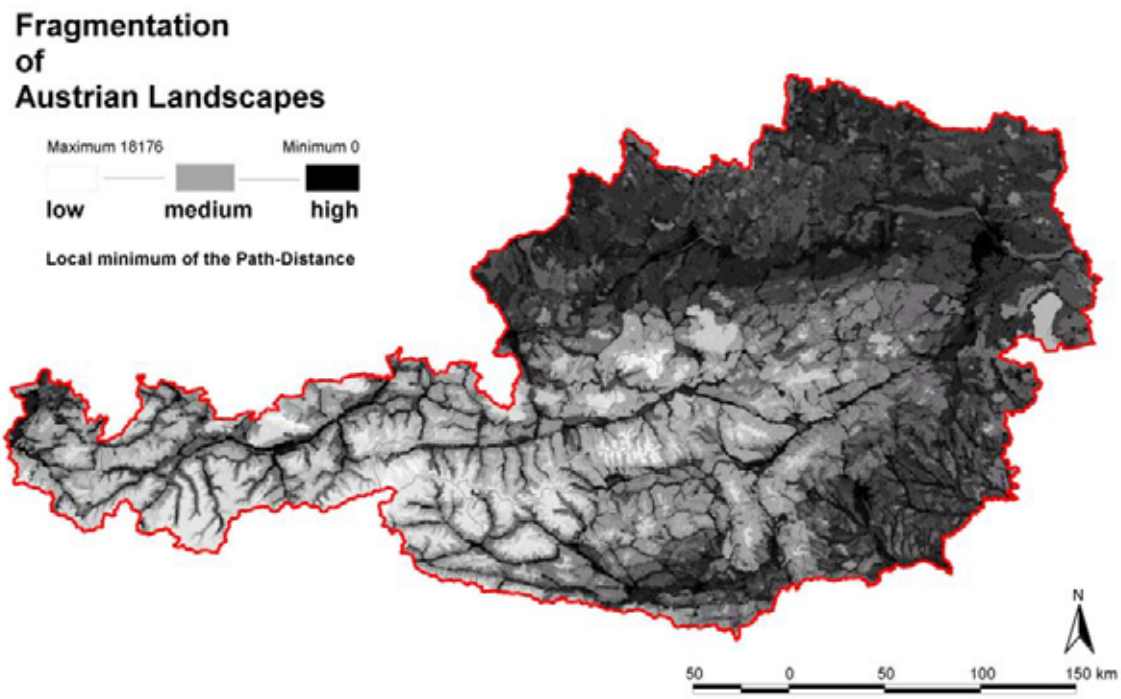

Figure 2. Fragmentation of the Austrian landscapes (Wrbka et al. 2001) showing the 'influence of traffic networks' on the landscape-type scale. Calculated as the local minimum of the real surface distance (path distance) of a given landscape cell to the next traffic infrastructure

The indicator remoteness (see Figure 3) was an attempt to identify wilderness areas as areas remote from the major traffic lines. The local maximum of the distance to the traffic infrastructure was used to sharpen the contrast between highly influenced and remote areas. Figure 3 illustrates that major parts of Austria including the Alps are affected by settlements and roads. On the other hand, there are sudden core areas of large undisturbed regions, which are far away from major traffic routes and bigger settlements. These remote areas are concentrated in the central High Alps but also in the northeastern Limestone Alps. A third cluster can be observed in the Hercynian Upland close to the Czech boarder. Whereas the remote areas in the Alps stayed undisturbed due to the harshness of the natural environment, which was an obstacle for human colonization, the remoteness of the boarder regions is caused by socio-cultural processes like the marginalization of regions along the former Iron Curtain.

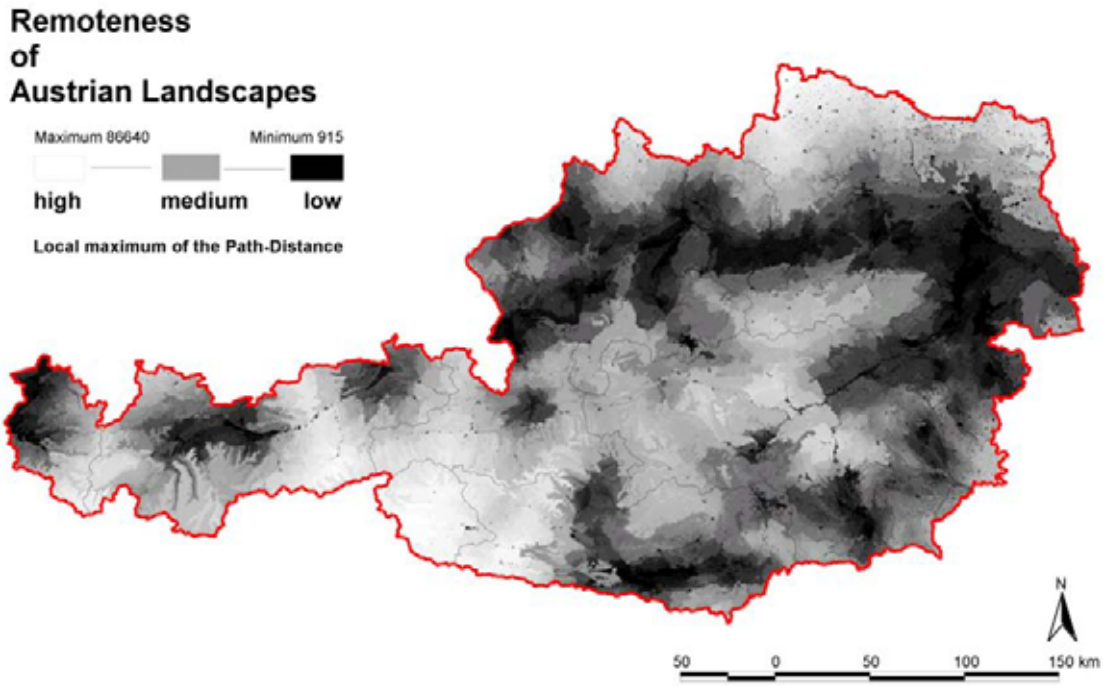

Figure 3. Remoteness of Austrian Landscapes (Wrbka et al. 2001) from the major traffic networks. Calculated as the local maximum of the real surface distance (path distance) of a given landscape cell to the next traffic infrastructure

The high remoteness of larger areas in Austria is a major factor for habitat quality for large migrating animals (Rauer and Gutleb 1997; Rauer et al. 2001). In the late 1980s the very small remaining population of the brown bear (*Ursus arctus*) was safeguarded by the release of Slovak and Slovenian individuals. This refreshed founder population has successfully established itself. In the meantime the number of brown-bear individuals exceeds 50, concentrating in two areas, namely the northeastern Limestone Alps and the southern Central Alps. Figure 4 shows the density of brown-bear sightings in the decade of 1989 to 1999. A clear correlation between the remoteness and the brown-bear occurrences can be expected. The remoteness of certain alpine areas is an important prerequisite for the survival of this big mammal, which has become an important flagship species for nature conservation in Austria.

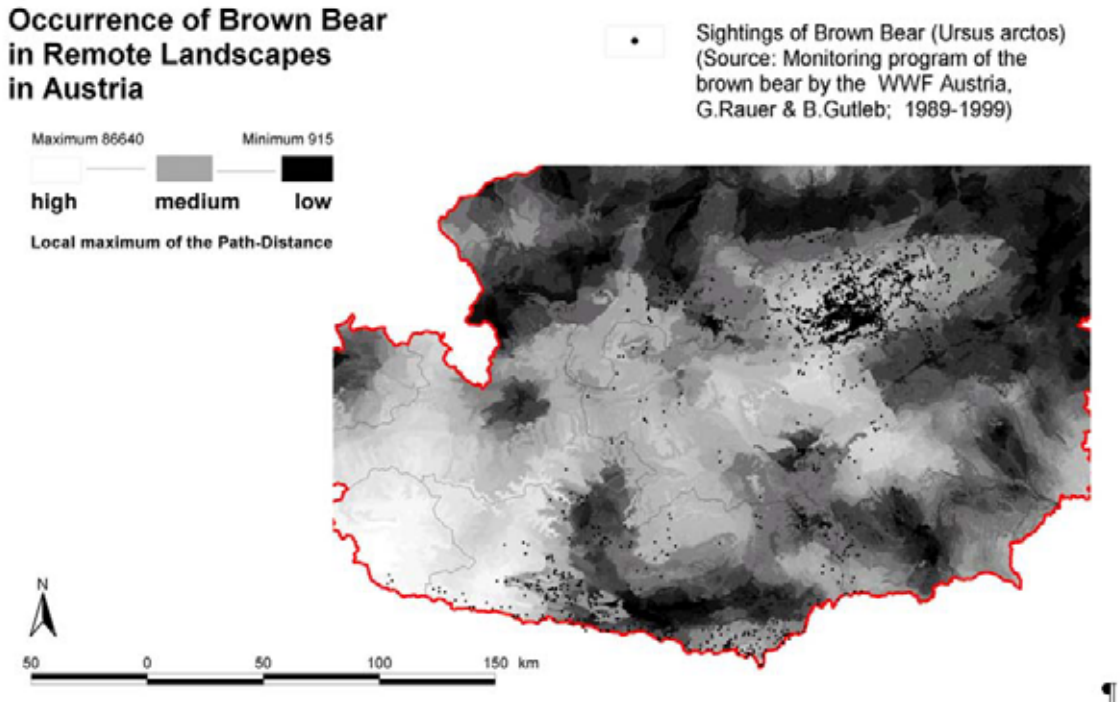

Figure 4. Occurrence of the brown bear in the remote landscapes in Austria (Source: Monitoring of the brown bear by WWF Austria 1989-1999). Remoteness calculated as the local maximum of the real surface distance (path distance) of a given landscape cell to the next traffic infrastructure

Human impact in alpine cultivated landscapes

Landscapes have been shaped by human activities according to their needs and possibilities and by the constraints of the surrounding environment since Neolithic times. The 'pattern and process' paradigm formulated by Odum and Turner (1990) states that there is a link between land-use intensity and landscape structure. Recent studies have shown that this is also true for Austrian landscapes (Wrbka et al. in press-a). The changes can be interpreted as a consequence of the massive input of fossil energy into Austria's agricultural system, which allowed an urge in the intensification of transport (Krausmann et al. 2003). Landscape structure can therefore be termed 'frozen processes', as the result of the interaction between the culture system and nature. An analysis of the influence of human impact on the landscape and the link to biodiversity and land-use intensity in Austrian cultural landscapes was carried out. About 180 landscape samples, each 1x1 km square in size, covering the whole variety of Austrian cultural landscapes, were investigated (Peterseil et al. in press; Vierlinger, Peterseil and Kutzenberger 1999) using standardized ecological attributes (Szerencsits et al. 1999). The method was developed under the influence of the British Countryside Survey (Bunce 1999). The sampling design was based on a stratified random-selection procedure. The hemerobiotic state, as a measure for the human interference in ecosystems following the concepts of Sukopp (1972) and Grabherr et al. (1998), turned out to be a good predictor for bryophyte species richness (Zechmeister and Moser 2001; Zechmeister et al. 2003b) as well as land-use intensity for vascular-plant species richness (Zechmeister et al. 2003a). The hemerobiotic state plays, as an integrated measure for the human influence on ecosystems, a central role in environmental reporting to governmental boards and to the public. In addition to that, similar surveys in the eastern part of Austria showed a

clear relationship between landscape complexity and species richness (Moser et al. 2002a; 2002b).

In the following paragraphs several examples are shown, presenting characteristic landscape patterns of cultural landscape in the Alps (see Figures 5 and 6). A correlation between landscape structure and biodiversity indicators could be found (Zechmeister and Moser 2001; Zechmeister et al. 2003a; 2003b).

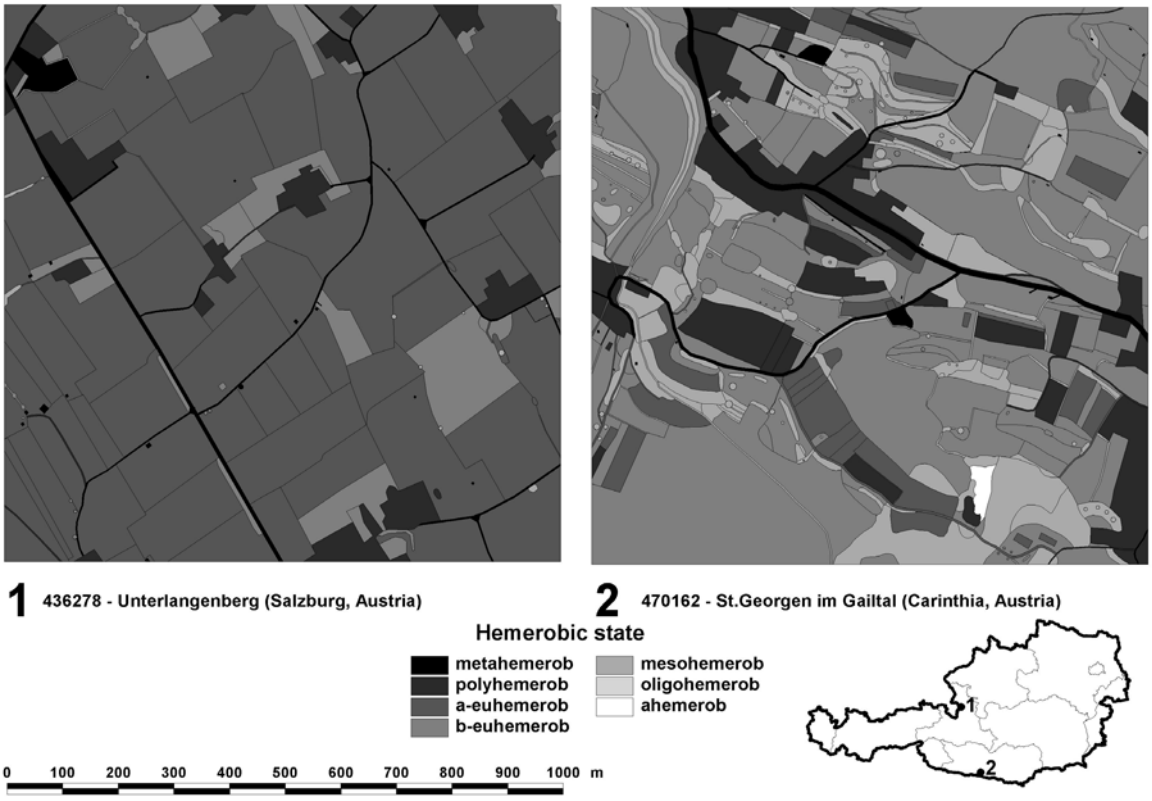

Figure 5. Landscape pattern and distribution of the hemerobiotic state for two grassland-dominated landscapes in the montane elevation range of the Austrian Alps: intensively managed grasslands in a flat valley bottom (5.1 *Unterlangenberg*, Salzburg) and cascading land-use intensity pattern in a traditionally managed grassland-dominated landscape with a more pronounced relief (5.2 *St. Georgen im Gailtal*, Carinthia)

The landscape sample '*Unterlangenberg*' (see Figure 5.1) is situated in the bottom of a broad valley and '*St. Georgen im Gailtal*' (see Figure 5.2) is part of a landscape type that is typical for steeper slopes of alpine valleys. Both landscape samples are located in the montane elevation range which covers the lower parts and the big valley bottoms of the Alps. '*Unterlangenberg*' (see Figure 5.1) is characterized by highly intensive agriculture based on permanent grassland and dairy farming. It is obvious that due to the almost flat terrain in the valley an intensive management of the land is possible. This results in a quite homogeneous landscape pattern. Natural or semi-natural habitats are nearly missing and restricted to non-productive areas. Only some residuals of the former less intensive agriculture contributes to the local biodiversity. Landscape elements like nutrient-poor grasslands or wetlands are often isolated from each other and threatened by afforestation. The remnants of these habitats are the main ecological infrastructure in these landscapes. The matrix of this landscape is highly transformed and following the hemerobia

concept it can be evaluated as α-euhemerobic (Figure 5.1: a-euhemerob), meaning that the ecosystems are completely dependent on human interference and have nothing in common with the potential natural state.

'*St. Georgen im Gailtal*' (see Figure 5.2) shows the picture of traditional mountain peasantry with mixed farming and a cascading pattern of land-use intensity. The higher geomorphological complexity sets limits to the colonization processes for human beings in the landscape (see Wrbka et al. in press-a). The land-use intensity shows a cascading pattern around the settlement, showing decreasing land-use intensity with increasing distance to the settlement. This reflects a traditional land-use pattern which was common in many alpine agricultural landscapes. In comparison to the first example a different picture can be shown. At least 15 % of elements show a moderate alternation and human influence, and can be classified as mesohemerobic (Figure 5.2: mesohemerob) elements. This means that these elements are either the remnants of the potential natural vegetation or traditionally maintained very extensively managed agricultural habitats – like hedgerows, small woodlots or extensive pastures. The matrix of this landscape is β-euhemerobic (Figure 5.2: b-euhemerob), indicating that most of the elements are transformed but still more species-rich. The biocoenoses have a small share of species that are originally found in natural conditions. The fairly low share of natural and semi-natural habitats may lead to the conclusion that alpine farming does not contribute to high nature value as such, but there are certain cases in which the traditional management of habitats is still preserving high biodiversity values. This is especially the case in landscape types with less favourable conditions for modern industrialized agriculture. In several studies the correlation between an intermediate disturbance regime and a high structural diversity of landscapes (Wrbka et al. in press-a) as well as species-richness (Zechmeister and Moser 2001; Zechmeister et al. 2003a) was found.

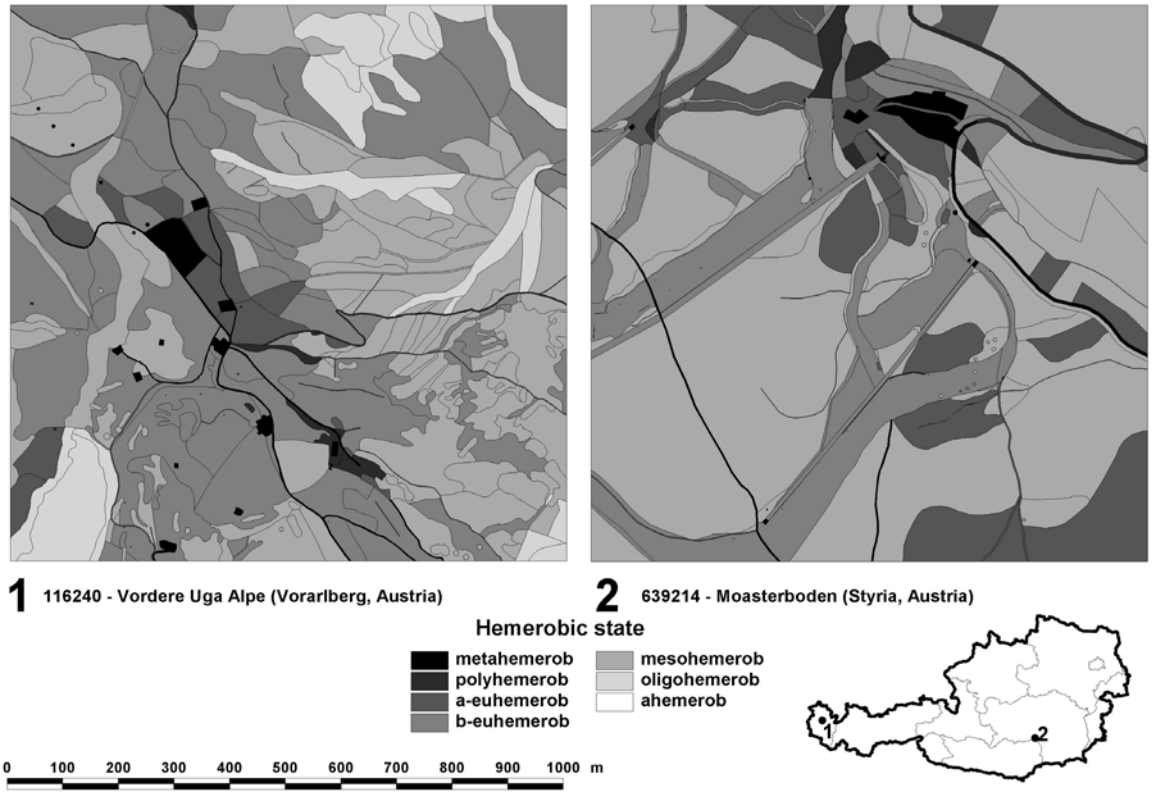

Figure 6. Landscape pattern and distribution of the hemerobiotic state in subalpine and alpine pasture landscapes. Traditionally managed pasture landscape in the western part of the Austrian Alps (6.1 *Vordere Uga Alpe,* Vorarlberg) and intensively managed and transformed pasture landscape in the southwestern part of the Austrian Alps (6.2 *Moasterboden*, Styria)

A second pair of sites (see Figure 6) illustrates the situation of sub-alpine and alpine landscapes, which can be found in higher altitudes above 1,500 meters above sea level. The landscape samples are situated in the so-called alpine pasture region (sub-alpine elevation range), which is of special interest for tourism in Austria. For thousands of years, the human settlers in the Alps have driven their livestock in the grassland-dominated landscapes above the alpine timber line. Pollen-analytic results for the western part of the Austrian Alps showed that the beginning of sub-alpine and alpine pasturing may date back to 4,300 B.C. (Bortenschlager 2000). Gradually the timber line was lowered and the mountain forest was replaced by anthropogenic habitats like mountain pastures (Bätzing 2003). For centuries this has created a semi-natural environment of fragments of mountain forest interspersed with large semi-natural grassland areas and dotted by periodic settlements, which were only used during the summer season. The most important effect of alpine farming on the vegetation was fragmenting the closed montane and sub-alpine forest belt. On the landscape level the emerging mosaics of forest patches and grasslands led to an increase of biodiversity (Dullinger et al. 2003). The landscape sample '*Vordere Uga Alpe*' (see Figure 6.1) in Vorarlberg in the western part of Austria still shows the basic feature of the traditional land-use system in these regions. The landscape shows a cascaded land-use intensity pattern, with intensively managed areas near the stables and decreasing land-use intensity with increasing distance to the settlement. Only a few fertilized and species-poor meadows can be found near the sheds. The matrix of the landscape is composed of semi-natural grassland with no direct fertilization. The matrix can be evaluated as β-euhemerobic (Figure 6.1: b-euhemerob). Remnants of natural vegetation can be found within the matrix. The transition zone between the medium-intensive pastures and the nature remnants is characterized by mesohemerobic (Figure 6.1: mesohemerob) to oligohemerobic (Figure 6.1: oligohemerob) elements like tall-herb vegetation, shrub and Krummholz, but also different kinds of heath land.

The landscape sample '*Moasterboden*' (see Figure 6.2) shows a more recent development of a landscape. Whereas in the sample '*Vordere Uga Alpe*' the land-use pattern and configuration have not changed dramatically, the landscape in the sample '*Moasterboden*' in Styria was transformed significantly. The local source of income changed from a mainly agriculture-based economy to tourism-based economy. Former mountain pastures were transformed to skiing ranges. Not only the area extent of artificial landscape elements, but also the geometry of the ski runs is revealing a completely different and also intensified modern land use (Wrbka et al. 1999). This change in the landscape pattern has major impacts on the local biodiversity. Fragmentation, alternation in the land-use regimes and sealing are the main processes.

Conclusions

Farming in the Alps has, for centuries, created a highly differentiated system of man–nature interactions with a variety of adaptations to the harsh environmental conditions (Bätzing 2003). The result was a set of landscapes that have significant

attractive scenery and thus a great importance for tourism. Apart from this, the high nature value of alpine landscapes does not only depend on agricultural land use. For the Austrian Alps it can be stated that those remote wilderness areas are equally contributing to the importance of the Alps as an international 'Biodiversity Hot Spot'. Today, agriculture itself is not the economically dominating land-use system in alpine regions and is undergoing the same transformation processes as it is the case in other European rural areas (Jongman 1996). Especially alpine valleys and basins are characterized by severe human impact, resulting in landscapes dominated by highly transformed elements. On the other hand, alpine farming in less favourable areas still preserves a great variety of traditionally maintained cultural landscapes, characterized by the significant occurrence of semi-natural extensively used habitats. The subsidies and direct payments play an important part in the economic stabilization of mountain farms. Although the proportion of public funding, in the total income of mountain farms from agriculture and forestry, is not higher than that for lowland farms, these direct subsidies have been an important factor in the successful maintenance of mountain farming and the traditional cultivated landscape in the past decades (Hovorka 1998).

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