

# **Complex interactions between land cover and land use in a changing peripheral landscape in South East Portugal.**

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## **Abstract**

Widely acknowledged, although often mixed up, are the different meanings of the concepts of land cover and land use. In dealing with multifunctionality of landscapes it is important to clarify the relations and interactions between these concepts, to monitor how both evolve through time and to see which developments can be expected in the near future.

When studying processes of land cover modification, land use change is normally a principal cause, however, this is not always an unambiguous relationship.

In a case study area in South East Portugal, land cover modifications over the last 100 years are studied on the basis literature research, aerial photographs and historical cartography. The study area is a peripheral agricultural area where one of the principal land use systems is an agro-silvo-pastoral system, consisting of a combination of open oak forest and a sub cover of pasture, arable land and shrubs.

The second part of the research consisted of interviewing farmers and landowners to disentangle the relationship between land cover and land use in past and present. Results show that in this case study area both land cover and land use have changed dramatically, however not always in a simultaneous way. In this paper we would like to discuss the complex relationship between land cover and land use in this part of Portugal, which, in our opinion, cannot be neglected in the current debate about multifunctionality of landscapes.

Keywords: Land cover, Land use, Landscape change, Landscape multifunctionality

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## Introduction

In landscape ecology, remote sensing, vegetation analysis, landscape planning and many other disciplines, research is dealing with processes concerning land cover and land use. Though quite distinct, both concepts are often used in a mixed way. However, when working with issues like landscape multifunctionality, it is of fundamental importance to make a distinction between land cover and land use.

Land cover can be defined as '*the observed (bio) physical cover on the earth's surface*' (Di Gregorio A. and Jansen 2000), and relates to the type of feature present like meadows, shrub area, forest, water bodies and built up area. Land cover can relatively easy be observed with the naked eye, on aerial photographs and on satellite images.

While land cover is only about the actual occupation of the earth's surface, land use is about human activities on a particular piece of land (Lillesand and Kiefer 1994). Land use can only partially be observed, additional information about the actual action is required and often not available. Examples of land use are: recreation, agriculture, forestry, residential and industrial areas.

A strict application of these definitions causes problems in mapping real live situations (Lillesand and Kiefer 1994). Many authors cope with these problems. Casimiro (2002) uses a mixture of land cover / land use classes to avoid the establishment of relations between cover and its uses. Regato Pajares *et al.* (1995) also uses a mix of a land cover/land use class, and others mix land use terminology within the land cover classification applied and vice versa (Iverson 1988), (Fjellstad and Dramstad 1999) (Kienast 1993). Also the Corine land cover classification for Europe contains some contradictions (Instituto do Ambiente and IGEOE 2005). Most of the classes used are land cover classes but also the land use class 'agro-forestry' is used.

From aerial photographs land cover is the main attribute to be observed, and to a certain extent it can be 'translated' to land use, but the relation is often not clear and ambiguous (Brown 2003). While the link between the land cover class 'grassland' and land use class 'agricultural production' is clear, the associated land use of for example, 'scrublands' is less obvious. This is especially true for Mediterranean landscapes, where land uses are intermixed and borders between plots are fuzzy. When dealing with multifunctionality of landscapes it is important to know what kind of functions, or uses, in the landscape are present, where they can be found and how to identify them. There fore clarifying the link between land cover and land use, which is often over-simplified, is desirable.

The purpose of this paper is to discuss the complex relationship between land cover and land use in a Mediterranean landscape and to explore what the issues encountered imply for research on landscape multifunctionality.

The paper presents, for a case study area in southeast Portugal the evolution of land cover and land use in the past and at present, covering a time span of 120 years. The study is based on literature research, aerial photo interpretation and interviews with local landowners.

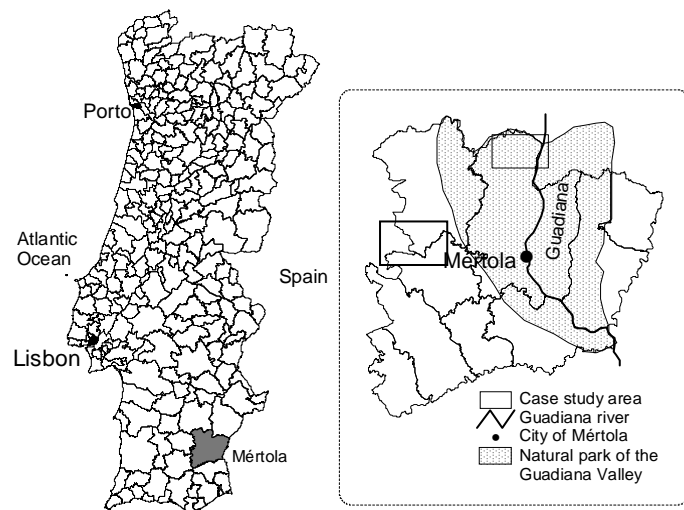
## Methods

### Case study area

The municipality of Mertola in the province of the Alentejo in Portugal has a long history of land use which traces still can be found in the present landscape. The open oak forest, with *Quercus rotundifolia* as the common species, occupies large parts of the area, especially the undulating areas. In combination with cereal growing and extensive livestock breeding this open forest is

called the Montado (Pinto-Correia 1993), which exists since the 12<sup>th</sup> century (Fonseca 2004) in this region. At the plane parts of the municipality the Montado is less represented and here cultivation and livestock breeding are more intensive.

At present the region is characterised by its peripheral location and the less favoured conditions for agriculture. The population density is very low and has been progressively decreasing last decades. Agriculture, forestry and hunting are main sources of income for the rural population. Besides old peasants, which normally own less than 50 ha, urban land owners possess large properties, of more than 200 ha, which are mainly used for hunting reserves and forestation projects. Forestation of former cultivated land, supported by regulation 1257/1999 which is one of the rural development measures of the Common Agricultural Policy, is one of the most visible and significant land cover changes that can be observed last decades.



**Figure 1 Location of case study areas**

Within the municipality two areas, Amendoeira da Serra and Joao Serra, of each 44km<sup>2</sup> are chosen as case study area see figure 1.

### Data gathering

Information about land cover, land use and agricultural practices of the period before 1958 is in this region limited. Though, some information can be found on historical land cover maps made by G. Pery in the end of the 19<sup>th</sup> century. Interpretation of these maps has been carried out by Mariano Feio (Feio 1998). More specific information about the agriculture of the province of the Alentejo and about the municipality of Mértola can be found in (Roxo *et al.* 1998) and (Feio 1983). With the emergence of aerial photography, data on land cover became much more accessible. Images of this region are available from 1958 on and photo interpretation has been carried out for five time periods: 1958, 1985, 1969, 1990 and 2000.

Data about the land use of the present and recent past was obtained through interviews with landowners. In the next paragraphs the approach of the interpretation of aerial photos and the interviews is presented.

### Land cover classification

For the interpretation of aerial photographs an extensive land cover classification of 20 classes was used, assuming that slight differences in land cover indicate different types of land use. In this way, detailed connections between land cover and land use could be established. Table 1 shows the extensive land cover classification.

Class 4 ‘arable land / pasture’ includes those areas that are characterized by the absence of trees and shrubs. It can include arable land as well as pasture. The shrub cover in this class is less than 20%.

Classes 5, 6 and 7 are shrub land classes, varying in height and density, which are in ecological as well as landscape

point of view clearly distinct. The classes are distinguished according to the nomenclature of (Tomaselli 1981) for matorral. Matorral is defined as a shrubby formation of woody plants related to Mediterranean

**Table 1: Land cover classification**

<b>Land cover classification</b>	
1	Hamlets / farm buildings
2	Water lines / reservoirs
3	Horticulture / orchard / Olive grove
4	Arable land / pasture, shrub cover<20%
5	Low, scattered matorral, shrub cover 20-50%
6	Middle, discontinuous matorral, shrub cover 50-75%
7	High, dense matorral, shrub cover>75%
8	Forest plantation, mixed
9	Forest plantation, eucalyptus
10	Forest plantation, pine
11	Forest plantation, Quercus suber
12	Forest plantation, Quercus rotundifolia
13	Montado, tree cover <10% shrub cover<20%
14	Montado, tree cover <10% shrub cover 20-50%
15	Montado, tree cover 10-30% shrub cover <20%
16	Montado, tree cover 10-30% shrub cover 20-50%

climates. Class 5 is low, scattered matorral and corresponds to natural pasture where sparse shrub covers 20 - 50% of the surface. The shrubs have a maximum height of 0,6 meter with common species as *Lavendula stoechas*, *Genista hirsute* *Helichrysum stoechas*.

Middle discontinuous matorral has a height between 0,6 and 2 meters, a shrub cover between 50-75% and is in this area a homogenous formation of *Cistus ladaniferus*. It grows mainly on former cultivated lands or recently burned areas, since *Cistus ladaniferus* is an active pyrophyte. This type of matorral might represent an alternative stable state, which is highly persistent in the absence of human intervention, because seed establishment of *Quercus* species is difficult in this kind of shrub formations (Acacio 2005).

The third shrub class is high, dense matorral, which can reach a height of more



**Figure 2: Different classes of Montado, above: Montado, between 5 – 10% tree cover and less than 20% shrub cover; middle: Montado, 5-10% tree cover and 20-50% shrub cover; below: Montado, more than 30% tree cover and less than 20% shrub cover**

than 2 meters, and can especially be found along the waterlines. It is a species rich, heterogenous formation with species like *Arbutus unedo*, *Olea Oleaster*, *Pistacia lentiscus* and *Quercus rotundifolia*.

Forest plantations are defined as areas where trees are recently (< 15 yrs ago) planted or sowed in a process of forestation, or those areas where less recently trees are planted in an artificially way, but where still the plantation lines are clearly visible. Usually the sub cover is bare soil with some dispersed shrub, depending on the type of management. Five classes of forest plantation are distinguished based on the main species planted.

The Montado is subdivided into 7 classes and differs from the agricultural area class, because of the tree cover of oak trees. Often these are holm oaks (*Quercus rotundifolia*), but some times cork oak (*Quercus suber*) does occur. The trees are visible as such on aerial photographs when they are approximately more than 10 years old. The first division within the Montado classification is made on the basis of tree density and corresponds to pan-European used classifications like Corine (Instituto do Ambiente and IGEOE 2005) and EUNIS (EEA 2005). Areas with more than 30% tree cover are considered as 'forest'. Between 10 –30% tree cover corresponds to 'open forest' and between 5 and 10% tree cover to 'scattered trees'. The second division is made on the type of sub cover: the presence or absence of shrub formations. When shrub cover is absent or covers less than 20% of the surface, the area corresponds to arable land / pasture. When 20-50% of the sub cover is covered with low shrubs it corresponds to the low scattered matorral. A shrub cover under the trees of more than 50% corresponds to the middle, discontinuous matorral. In this case a distinction between tree cover was not made, because of difficulties in visibility. The different combinations of tree and shrub densities result in 7 classes of Montado, see figure 2 for some examples.

Aerial photographs of 3 years were used: 1958, 1969, 1985. For 1990 and 2000 digital orthophotomaps were used. The scale of the aerial photographs varied between 1:26.000 and 1:15.000. The orthophotomaps had a resolution of 1 meter. The photographs were scanned with a resolution of 600dpi and ortho-rectified, using the orthophotomaps of 2000 as georeference. Identification of the land cover classes was done on screen and with elaborate fieldwork for the present situation. Digitizing was done in ArcView 3.2, using a minimal mapping unit of 500m<sup>2</sup>.

## Interviews

To obtain information on the land use associated with the land cover observed we interviewed the landowners about past and present land use and management of their properties. A closed question list, consisting of 28 questions dealing with past and present land use, the livestock, changes in land use and the use of the less favoured parts of their property, was used for this purpose.

Because the property structure was known and most interviews were done with the use of aerial photographs or in the field, direct relations could be made between the aerial photo interpretation and the information obtained during the interview.

The sample of the farmers had to cover the wide range of different types of landowners who owned together at least 80% of the study area.

## **Results**

### Land cover and use before 1958 based on literature research

According to the historic agricultural maps of G. Pery, the region of the study area was in 1888 mainly covered with shrubs 'charneca' which were indicated as unproductive area (Feio 1998), except from some small spots with arable land and orchards. The scrub area was communal used for hunting, the production of honey and wax and the collection of firewood. But they were also important for livestock breeding (Roxo *et al.* 1998). In the beginning of the 19th century more and more natural vegetation turned to agriculture, because of a severe increase of the population, cereal growing became one of the main activities.

This development reached its optimum in the beginning of the 20th century, due to political incentives, improvement of the infrastructure and organization of the agricultural markets. Large areas of uncultivated land, with very poor conditions for agriculture were taken into production. In the first half of the 20th century cereal growing was the most important source of income of the region.

### Aerial photo interpretation

The importance of cereal growing is clearly visible on the aerial photographs of 1958. Figure 3 shows the land cover map of this year and the one of 1985 and 2000 for the case study area of Amendoeira da Serra, the one that shows most dramatic changes during the study period. In 1958 arable land and pastures, land cover class 4, are dominating the study area, accounting for 66% of the area. Around the settlements there is some Montado (16%), mostly with a tree cover of more than 30% and without a



shrub cover. On the steep banks of the rivers high dense matorral can be found. Obviously connected with the difficult physical conditions, cultivation is not possible here.



**Figure 3 Land cover maps of 1958, 1985 and 2000 for study area 1: Amendoeira da Serra**



The land cover maps of the following year shows a gradual increase of matorral and Montado area. A shift from open land, arable land and pastures without trees, to a more closed landscape with open oak forest and shrubs takes place. The montado is more varied in terms of tree and shrub densities. The matorral does not only appear along the waterlines but also at the more favored areas for agricultural production, there being the low, scattered and the middle discontinuous matorral. Also the first forest plantation appears in the northeast corner of the study area

At the land cover map of 2000 we see a significant occupation by forest plantations, accounting for 30% of the whole area. Different tree species are planted, being *Q. suber* and *Q. rotundifolia* the most frequent ones. Mostly arable land / pasture and low, scattered matorral are used for afforestation, but also montado areas and middle, discontinuous matorral are turned into plantations. The area of arable land and pastures occupies only 13 % of the area, while montado accounts for 30%.

## **Interviews**

### Trends in past land use

In total 44 landowners were interviewed in the spring of 2004.

In terms of land use, most early memories of the interviewees go back to the era of the intensive cereal growing, 'where now shrubs are, used to be cereal growing', 'everybody was sowing wheat'. People refer to the traditional rotation system of one or two years of cereal growing, often wheat, but also oats and barely; followed by 2-4 years of fallow in combination with livestock grazing, which can be sheep, cattle, goats or pigs. This type of management includes regularly ploughing of the soil, which prevents shrub encroachment.

Until the 60's it stayed like that, than some farmers began with some other activities like dairy farming. The period 1974 – 1986 was, according to the interviewees, characterized by a decline in cereal production.

The interviewees mentioned the strong influence of the mechanization, which started in the middle 70's. Due to this development a selection among the farmers took place, the ones which were big enough to join the mechanisation, were able to keep on going with cereal production. The others, smaller, without budget for machinery, searched for other activities. Another result of the mechanization was that cereal growing on the more difficult parts of the cultivated area stopped: 'all which couldn't be worked with machines was left'. So some farmers kept on cultivating the same, although in a mechanized way, and others searched for alternatives and changed to

extensive livestock breeding. In the end of the '80's many people refer to the growing shrub area: 'it was full of shrub' and at that time new comers bought some properties.

For the period 1986 to present the interviewees refer to the forest plantations which started in the early 90's and continue to present day, the fencing of the properties, mainly because shepherds were disappearing, and cleaning of shrub areas.

In terms of livestock the trends are diverse. 8% of the interviewed land owners used to have livestock but stopped with breeding when limiting factors as aging and declining available workforce were gaining importance. Then there are some properties that used to have a diversified stock of sheep, goats, horses and pigs which grazed different parts of the property. Today those properties are less diversified, there is a trend of specification on the breeding of one particular type, which is often sheep. For 5% of the interviewed land owners there did not change anything in terms of livestock breeding, they always had sheep and keep on doing like that.

In general the number of goat flocks, which grazed normally in the middle to high matorral has been declining, while the number of sheep has been rising.

#### Present land use

At present 45% of the interviewed land owners has livestock breeding as main source of income, while for 25% this is the subsidy of the forest plantation and another 25% is retired.

56% of the landowners who have livestock has only sheep, there are also some farmers cattle and pigs and there are just a few with goats. In the area, all livestock breeding is aimed at meat production. Some farms with livestock maintain a rotation system: a part of the land is cultivated with cereal, which is mostly allocated for fodder, and after this it lays fallow for 1 to 4 years. Some farmers only have grasslands, which are only cleaned from shrub encroachment once in a while. Grass productivity is low, in consequence the stocking rate is, on average, 0.36 gross cattle unit per hectare

Of the 55% of the landowners who do not have livestock, the majority has planted, a part of, their land with forest. Others are retired and rent their land out to others. In the latter case two arrangements are possible: renting with a long term contract to a neighbouring farmer, or sell every year the pasture to the highest bidder. In both cases the land is maintained and regularly grazed.

The afforestations are mainly plantations of cork (32% of the landowners) or holm oak (21%), constructed in the last 15 years and because of lucrative subsidies of the CAP provide a convenient source of income. Their management is restricted to the regulations that are associated with the subsidies. Farmers are obliged to maintaining a

minimum level of tree density and have to keep the plantation free from shrubs the first five years. After this period, livestock grazing in the plantation is allowed, but the management of the plantation depends very much on the type of tree planted. Forest plantations with *Q. suber* and *Q. rotundifolia* might be managed as the traditional agrosylvo pastoral system. For a couple of farmers this prospect inspires to start breeding the black iberian pig, originally a fundamental part of the montado system. Other tree species, like eucalyptus and pine do not offer this kind of possibilities since the species are less integrated in the traditional land use.

Hunting and bee keeping are other land use which were frequently mentioned during the interviews. Especially the areas with matorral are important for these activities, because of their importance for flora, insects and game animals. There are several types of hunting regimes which earnings can be quite profitable. Tourism and recreation are not yet well represented in the area, though some land owners acknowledge their potential importance for the region.

#### Land cover – land use

Through the information obtained by interviewing the farmers it was possible to relate land cover what was identified through aerial photo interpretation to land use and management. This relation is almost never a 1:1 ratio, where one land cover corresponds to one land use and vice versa. Often one land cover class has various uses, and one land use can have many land covers. Table 2 shows the land cover classes as used for aerial photo interpretation with associated land use classes as derived from the interviews.

As well as in the past as in the present water lines are used for fishing, are a popular hotspot for hunting and serve as a watering place for livestock. Since 1985 reservoirs are appearing which serve primarily as watering place for livestock. With the emergence of the forest plantations, wild fire prevention became especially important, and together with the plantation, the construction of a reservoir is obligatory.

The open area arable land / pasture is normally subject to a rotation cycle of 3-5 years as described in the paragraph before and serve as such mainly the function of agricultural production. The low, scattered matorral is not subject to this rotational system. There is livestock grazing but no crop growing, the area stays open through extensive grazing, but due to the low grazing intensity and the absence of ploughing practices small shrubs can germinate. Because of the heterogeneous pattern of alternating shrub densities the matorral area, is an attractive area for game animals. In

the past wild herbs were collected for home consumption and the small branches of the shrubs served as kindling wood.

The middle, discontinuous matorral and the high, dense matorral were in the past the grazing place for goat, since their diet allows more woody species than other livestock types and are better adapted to the steep slopes where these types of matorral often can be found. The area was also used for firewood collection and bee keeping, and especially the high dense matorral was valuable because of the fruit production of for example *Arbutus unedo*.

At present the goats have almost disappeared and the areas of middle and high matorral are not grazed anymore, though the areas continue to serve for hunting and honey production. The forest plantations have different aims of use and are partly subject to the regulations of the CAP. The mixed plantation in the area was constructed in the eighties without forestry purposes but within the framework of a tourism project in the 80's. The project did not continue but the trees are still there, without a clear objective. The Eucalyptus plantation, not related to the CAP subsidies, is primarily for wood and cellulose production and is harvested every 15 years.

The other forest plantations are supported by the CAP and their management is the first 10 years after plantation dictated by the regulations associated to the subsidies as described before. On long-term pine serves for the production of wood, while the plantations of the *Quercus* species can turn into the traditional Montado system. *Quercus suber* plantations are destined for cork production, but also serve as a shelter place for livestock and prevention of soil erosion. The same counts for *Quercus rotundifolia* plantations, additionally the acorns of this species serve as for fodder for pigs, sheep and cattle and firewood is an important product through regularly pruning.

In the Montado different tree densities did not clearly indicate different use, although the forest products, as cork, acorns and firewood become increasingly important when tree density is higher. The different shrub densities are closely related to the type of management and levels of disturbance. When the shrub cover is less than 20%, the area is frequently grazed and once in a while ploughed. A shrub cover between 20–50% indicates probably an extensive grazing of the area, where ploughing is not practiced anymore. A shrub cover of more than 50% indicates a very low level of disturbance. The heterogeneous pattern of alternating tree and shrub densities of the Montado constitutes an attractive landscape for game animals and insects and is in this way important for hunting activities and honey production.

	Land cover		Land use past	Land use present
1	Hamlets / farm buildings		Residential	Residential
2	Water lines / reservoirs		Hunting, fishing, watering place for livestock	Wildfire prevention, hunting, fishing, watering place for livestock,
3	Horticulture / orchard / olive grove		Production of fruit and vegetables for home consumption	Production of fruit and vegetables for home consumption
4	Arable land / pasture		Livestock grazing, Cereal production, hunting	Livestock grazing, Cereal production, hunting
5	Low, scattered matorral		Livestock grazing, hunting, fire wood collection, herb collection	Livestock grazing, hunting
6	Middle, discontinuous matorral		Goat grazing, fire wood collection, honey production, hunting	Hunting, honey production
7	High, dense matorral		Goat grazing, fire wood collection, fruit and herb collection	Hunting, beekeeping, nature conservation.
8	Forest plantation, mixed species.		-	Wood production, honey production
9	Forest plantation, <i>Eucalyptus</i> .		-	Wood production, harvest every 15 years.
10	Forest plantation <i>Pinus pinna</i>		-	Wood production, single harvest after 40 years,
11	Forest plantation <i>Quercus suber</i>		-	Cork production, after 26 years first cork yields.
12	Forest plantation <i>Quercus rotundifolia</i>		-	Pruning for firewood, fodder and shelter for livestock.
13	Montado t.c.<10%	s.c. <20%	Cereal growing, mixed livestock grazing, hunting,	Cereal growing, sheep and cattle grazing, hunting,
14	Montado t.c.<10%	s.c. 20-50%	Livestock grazing, hunting,	Sheep and cattle grazing, hunting,
15	Montado t.c.10-30%	s.c. <20%	Cereal growing, mixed livestock grazing, wood, acorn and cork production, hunting	Cereal growing, sheep and cattle grazing, wood, acorn, cork production, hunting.
16	Montado t.c.10-30%	s.c. 20-50%	Mixed livestock grazing, wood, acorn and cork production, hunting,	Sheep and cattle grazing, wood, acorn, cork production, hunting,
17	Montado t.c.> 30%	s.c. <20%	Cereal growing, mixed livestock grazing, wood, acorn and cork production, hunting,	Cereal growing, sheep and cattle grazing, wood, acorn and cork production, hunting,
18	Montado t.c.> 30%	s.c. 20-50%	Mixed livestock grazing, wood, acorn and cork production, hunting,	Sheep and cattle grazing, wood, acorn and cork production, hunting,
19	Montado t.c. indiff.	s.c. >50%	Wood/ cork production, hunting,	Wood / cork production, hunting,
20	Bare rock		-	-

**Table 2: Land cover classes with associated land use in past and present**

The case study areas discussed in this paper are originally characterized by mixed land uses, and despite severe land cover and land use changes this multiple character continues to exist.

Summarizing these observations we can conclude that in the case study area:

- 1) shrub areas have low disturbance levels, nevertheless, this does mean that it is not-used area, the areas often have a multiple use;
- 2) some land cover changes correspond to land use changes, like the decrease of agricultural area goes together with the reduction of cereal cultivation; other changes do not go perfectly together, like the increase of shrub area and the decrease of goat grazing;
- 3) forest plantations do not necessarily serve one, forestry, goal, but various, especially in the case of the oak species which are integrated in the traditional agro-silvo-pastoral systems;
- 4) agricultural production, like cultivation and livestock breeding, forestry and hunting do not belong to one singular class but are associated to many land cover classes; this is also true the other way round, one land cover class has various land uses.

Furthermore when significant levels of disturbance, like ploughing or grazing determine the land use, its translation from the observed land cover can be quite straightforward. Although, the other land uses might not be forgotten. When disturbance levels are lower, translating land cover into land use is getting more difficult, because of the less visible traces of human activity.

### **Implications for the research on multifunctionality of landscapes**

The concept of multifunctionality is gaining attention, in landscape sciences and in society, since the concept supports the principle of sustainability, and aims at integrating ecological, economic and social functions. Also in the ongoing debate about sustainable development, agricultural policies and international trends, multifunctional agricultural landscapes have become a central issue. There will be high demands on the landscapes of the future, which will have to serve simultaneously various functions.

Landscape multifunctionality is considered as the dynamic coexistence of different landscape functions, like ecological, economic, cultural, historical and aesthetic functions, within a single landscape (Brandt and Vejre 2003). The assessment of multifunctionality of landscapes starts with the identification of the functions present. Important hereby is that one single land use might contain several functions, so identification of several land uses in a landscape might imply the presence of even more landscape functions.



To obtain an impression of the land use in an area, which might be followed by an assessment of multifunctionality, identification of the land cover is often the first step taken. However, the results of this paper show that this translation from land cover to land use should be done in a careful way, in order to avoid oversimplification of the versatility of the land use and consequently of the multifunctionality of the landscape under study.

The method applied has shown to be useful when the aim of the study is to establish the connections between land use and land cover. Yet, the method is labor intensive and is therefore only applicable in small case study areas.

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