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„KULAWI“ – STRATEGIES FOR THE CULTURAL LANDSCAPE OF THE FUTURE

KERSTIN SCHREINER[1], CAROLINE PECHER[1], MARKUS SCHERMER[4], GERHARD SIEGL[3], ULRIKE TAPPEINER[1,2], ERICH TASSER[1]

[1] European Academy Bozen/Bolzano (EURAC), Drususallee 1, 39100 Bozen, Italy;
e- mail: Kerstin.Schreiner@eurac.edu
[2] Institute of Ecology, University of Innsbruck, Sternwartestr. 15, 6020 Innsbruck, Austria
[3] Institute of History and Ethnology, University of Innsbruck, Innrain 52, 6020 Innsbruck, Austria
[4] Department of Sociology, Universitätsstraße 15, 6020 Innsbruck, Austria

Abstract

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An intact landscape has not only an esthetic value, but it also increases the quality of life for the resident population and attractiveness for tourists. The landscape also provides essential ecological services for society, such as soil conservation, preservation of biodiversity, and provision of clean water. The typical cultural landscape in Tyrol and South Tyrol was developed in the 15th century. Cultural-landscape differences arose from different legal traditions between East and West and from a changed legal situation after the affiliation of South Tyrol to Italy. Moreover, the opening of the markets during the 19th century had the following consequences: Favourable locations were increasingly intensified while peripheral locations became less important and were partly abandoned. Since succession processes proceed slowly in the landscape, the extent of the consequences of land-use changes,such as forest re-growth, are only observable after many decades. This study presents an integrative methodical approach that allows comparisons between diverse geographical regions. The applied indicators enable an accurate monitoring of all major features of landscape change including changes in land use, landscape structuring, habitat settings, and urban sprawl. They further provide high-quality and realistic results for our study areas of Tyrol and South Tyrol.

Key words: agriculture, landscape change, habitat diversity, land-use

Introduction

The ever-changing history of Tyrol and South Tyrol has had a decisive impact on the development of these regions. This is particularly true for the development of the cultural landscape which reflects historical land use.

The typical Tyrolean landscape emerged following a massive attack of Baiuvarii (Bajuwaren) and Alemannii (Alemannen) between the 6th and the 15th century and it remained constant over many centuries (Bätzing, 1991). The settlers introduced new legal systems: in the east of Tyrol and South Tyrol, the Baiuvarii implemented a law which allowed the transfer of an entire farm estate to only one heir (Anerbenrecht). Contrary to this, the land in the west of Tyrol (Alemannen) was divided equally among all heirs (Realteilung). However, as a consequence of a continuous splitting of farms, they were no longer able to survive. During the 19th and 20th century, a socio-economic revolution caused radical changes in traditional life forms. As many people in rural parts of mountainous areas could not earn enough capital to survive, they had to emigrate to towns. While rural depopulation was reaching dramatic proportions, in other Alpine regions such as France, this was rather modest in Tyrol. The hereditary farm provided at least sufficient means to earn a living for the families. After the First World War, South Tyrol was affiliated to Italy and after the end of the Second World War and the subsequent pressure of modernization, the pressure on agriculture again increased. Farming activities in the Alps became increasingly marginalized due to unfavorable site conditions. In South Tyrol, support for rural areas started very early, mainly in the form of investments. A strengthening of rural areas was possible due to South Tyrol's autonomy. This political measure halted migration of the rural population and it assured the survival of full-time farming. In Tyrol, however, many farms were already being operated as part-time farms, and survival was not guaranteed. Since tourism alone could prevent depopulation of numerous valleys in the Alps, rural depopulation occurred where this mass tourism did not develop, as in Lechtal, Tyrol.

The consequences of depopulation and abandonment, as well as mass tourism and intensification in Tyrol and South Tyrol, can only be noticed over decades. Slow natural succession due to abandonment of agricultural areas and changes in the landscape as a consequence of agricultural intensification are a stealthy process. All these historical occurrences and developments changed the face of the landscape. The project "KuLaWi – Strategies for the cultural landscape of the future" concentrates on the historical, present and prospective landscape in the geographical region of Tyrol – South Tyrol. It further aims at defining and quantifying the driving forces of landscape change. The main emphasis is placed on the development of agriculture and forestry which cover approximately 70% of the project area's surface.

Material and methods

Test regions

Our project area spans the Autonomous Province of South Tyrol and the Province of Tyrol. South Tyrol is situated in Northern Italy in the inner-Alpine area. It spans regions along the Alpine main ridge as well as parts of the Dolomites (Fig. 1).

Tyrol is situated in Western Austria in the Eastern-Central Alps. It spans parts of the Northern Limestone Alps as well as regions along the main Alpine ridge.

Fig. 1. Location of the study areas and the selected municipalities.

The test regions can generally be divided into two different climate zones. In a north-south profile of this area, the Alpine fringe can be distinguished from the inner-Alpine zone. The northern Alpine fringe can be assigned to the Central-European climate region, where air streams from the west and the east are typical. The inner-Alpine zone is characterized by high altitudinal differences between high mountains and deep valleys. The climate in some valleys differs completely from the climate in the rest of the inner-Alpine climate zone. These valleys are sparsely populated and have less precipitation.

The Vinschgau belongs to the dry inner-Alpine climate type which is characterized by low precipitation amounts through even distribution of precipitation at high variability, and a temperature profile similar to that of the Central-European one. The long-standing average precipitation near the village of Matsch at 1.570 m a.s.l. is 526.7 mm and the average annual temperature is 6.6 °C (Hydrographisches Amt der Autonomen Provinz Bozen – Südtirol. 2010).

The climate of the Stubai Valley and the Pustertal approximates the northern Central-European type. It´s typical features include high amounts of precipitation, many rainy days, a distinct maximum rainfall during summer with little variability from year to year and a typical Central-European temperature profile. The average precipitation near the village of Neustift in the Stubai Valley at 970 m a.s.l. is 852 mm and the average temperature is 6.3 °C (Hammerle et al., 2007). The average precipitation in the municipality of Anholz-Mittertal is 890 mm with an average temperature of 6.6 °C (Hydrographisches Amt der Autonomen Provinz Bozen – Südtirol, 2010).

The Lechtal has a cool-humid Alpine-fringe climate, characterized by high precipitation over 1.100 mm with a distinctive summer precipitation maximum. In contrast to the inner-Alpine zone, the Alpine fringe is characterized by less temperature differences (Bundesforschungs- und Ausbildungszentrum für Wald, Naturgefahren und Landschaft). The city of Reutte at 870 m a.s.l is the principal town of Lechtal and it has an average precipitation of 1.376 mm and an average temperature of 6.1 °C (Zentralanstalt für Meteorologie und Geodynamik, 2010).

The highest altitude in our test region is the Weißkugel mountain between the municipalities of Mals and Graun (Vinschgau) with 3.738 m a.s.l, while the lowest altitudes are situated at 680 m a.s.l. in Schönberg im Stubaital (Tyrol).

Detailed analysis representative of the complete project area was conducted for selected municipalities in Lechtal and Stubaital which are both inTyrol, and also for the upper Vinschgau and the eastern Pustertal located in South Tyrol.

By choice, the landscape development was analyzed in comparison with depopulation and well-developed tourism areas, mountain farming and intensive fruit-growing regionsThis included the transfer of an entire farm-estate to one individual heir (Anerbenrecht) and an equal division among all heirs (Realteilung). Additionally, focus groups were formed with farmers from the selected municipalities with the aim of obtaining concrete background information concerning the land-use development and to identify strategies for future farm management.

With regard to landscape ecology, twelve representative municipalities were selected, as the municipality was taken as the smallest administrative unit herein. This methodology ensures that reliable, standardized and socio-economic statistics are available for the interpretation of land-use changes within each unit.

Methods

In order to investigate landscape development, our methodical approach includes the important aspects of landscape development such as land use, landscape structure and urban sprawl. These aspects are mapped at a scale of 1:25 000. Our methods range from remote sensing techniques, comprising the analysis of aerial photographs and historical maps, through historical research in archives to field surveys which included interviews. The cartographical editing of the land-use data was carried out using a Geo-Information System (GIS). The mapping scale was set at 1:10 000, using a minimum mapping-unit of 4 ha (2x2 cm at a scale of 1:10 000). Furthermore, the subdivision of the landscape into eco-regions, the choice of the data sources and the precise definition of indicators of land use, landscape structure and urban sprawl allows the universal use of this approach. This has three key advantages (Tasser et al., 2009):

- complex mountain landscapes and small-scale areas can be appropriately mapped,
- relevant information for stakeholders and decision-makers is provided,
- subdivision of the study areas into eco-regions, different geographical regions and regions with differing development allows comparison between the different parts of the study areas.

Materials

Within our project, the historical source of information is the Francisco-Josephinian Cartographical Register (the third cartographical register of the Austrian crownlands; 1:25 000) which was named after Emperor Franz Josef I. The maps were "large-scale maps" drawn up from 1869 to 1887 at a scale of 1:25 000. These maps depict the different land-use types from forests to lightly-used meadows, pastures, larch meadows, permanent crops, arable land, and settlements, and also specific landscape features such as rocks, moors, and rivers. In general, the use of such a map is not unproblematic since it is only available for the former Habsburg Empire. However, unfortunately there is no cartographic material available between 1887 and 1955. This gap had to be filled from other information sources. Geo-rectified aerial photographs with a mean scale between 1:15 500 and 1:25 500 were utilized for 1955, 1973 and 1985, while Orthophotos in a scale of 1:10 000 were used for 2000 and 2006. With this data it was possible to reconstruct landscape development during the last 150 years, and all interpretation and mapping was achieved by on-screen digitizing with a GIS.

Eco-regions

Topographical features such as altitude and slopes and also the climatic conditions do not normally allow uniform land use. It was therefore necessary to subdivide municipalities into eco-regions (Ruffini et al., 2004). These comprised landscape units which originated through the interaction of biotic and abiotic site conditions, agricultural and silvicultural usage and settlement and infrastructure development. Ten different eco-regions were distinguish between in this study. In the colline and montane zone there are agriculturally used valley slopes and floor and a forest belt. The subalpine zone includes a forest belt and agriculturally used alpine pastures, while the alpine zone has agriculturally used alpine pastures and near-natural grasslands. Finally, the nival zone represents an unvegetated belt.

Landscape indicators

Four landscape indicators were used in our approach: land-use types, habitat distribution, landscape structure and urban sprawl.

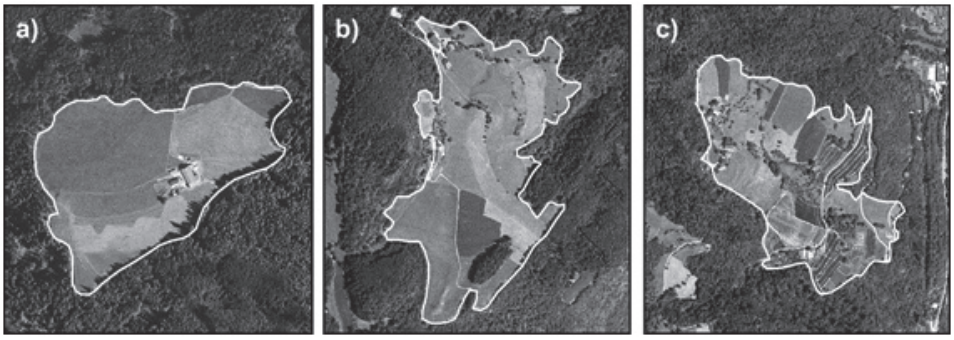

Fig. 2. Classification of heterogeneity and homogeneity using the culture form grassland as an example: (a) Pure grassland (4-level 1; share of other culture forms is below 5% of the whole area), (b) mixed grassland (4-level 2) with arable farmland and forest zones (share of other cultural forms is between 5 and 25% of the whole area); (c) mixed grassland (4-level 3) with fruit plantations and vineyards (share of other culture forms is between 25 and 50% of the whole area) (after Tasser et al., 2009).

Land-use types

The land-use indicator allows a statement about heterogeneity and homogeneity of the landscape, the form of land use and the degree of human influence (Fig. 2). Our evaluation subdivided land use into monocrop and mixed crops. Monocrops comprise a main culture-type that makes up at least 95% of the total crop of the analyzed area, whereas mixed crops denote that there is more than 5% of other crops in the area.

Habitat types

Habitat types comprise natural, near-natural and artificial habitats, showing a special biological or cultural landscape-valency. Mapping and classification of these areas is based on the physio-sociological principles defined by Ruffini et al. (2004) (Table 1). The classification is extensively hierarchically ordered, and it is based on vegetation-sociological information from the Central and Southern Alps (Ruffini et al., 2004).

Table 1. The most common habitat types and complexes in Tyrol and South Tyrol according to Tasser et al. (2009).

Code	**Habitat type**	**Code**	**Habitat type**
100	lake with littoral and silting zones	313000	rock
500	rocks and scree slopes with snow-packs	314000	scree slope
111000	lake	322000	natural alpine grassland
113000	watercourse	322220	dwarf shrub communities
130000	wetland, moor	411100	fruit plantation
133000	cane brake	411200	vineyard
211000	knee timber	412000	arable farmland
212000	green alder shrub	421000	rough meadow
221000	subalpine coniferous forest	422000	xeric grassland
222100	montane spruce-fire forest	423000	fodder meadow
222200	pine-forest	451000	orchard meadow
231000	wet forest	452000	larch meadow
232000	thermophile oak forest	470000	hedgerow
234000	mesophilic mixed deciduous forest	511000	dense urban settlement
310000	alpine pioneer formation	512000	rural settlement
311000	glacier and snow-pack	550000	industrial area

Landscape-structuring degree

Individual, small and linear landscape features such as groves, hedges, single trees, banks, debris areas and smaller habitats including marshland, rocks, and scree slopes integrated in completely differing habitats are defined as structural elements. All these elements contribute to the landscape texture. They confer specific importance, because they break the monotony of intensively used landscapes, they subdivide the landscape, they provide a refuge for small animals and they enrich the structural landscape. The landscape-structuring degree is therefore an important criterion for the enrichment of landscape quality and for landscape change (Fig. 3).

Urban sprawl development

Urban sprawl development is an important factor in measuring the anthropogenic influence on the environment (Antrop, 2004; Tjallingii, 2000). Herein, settlement activity in the open cultural landscape is described, and all buildings with a ground area of more than 16 m^2 outside settlement areas with less than 25% of green areas, such as parks and gardens, were collected as a data base.

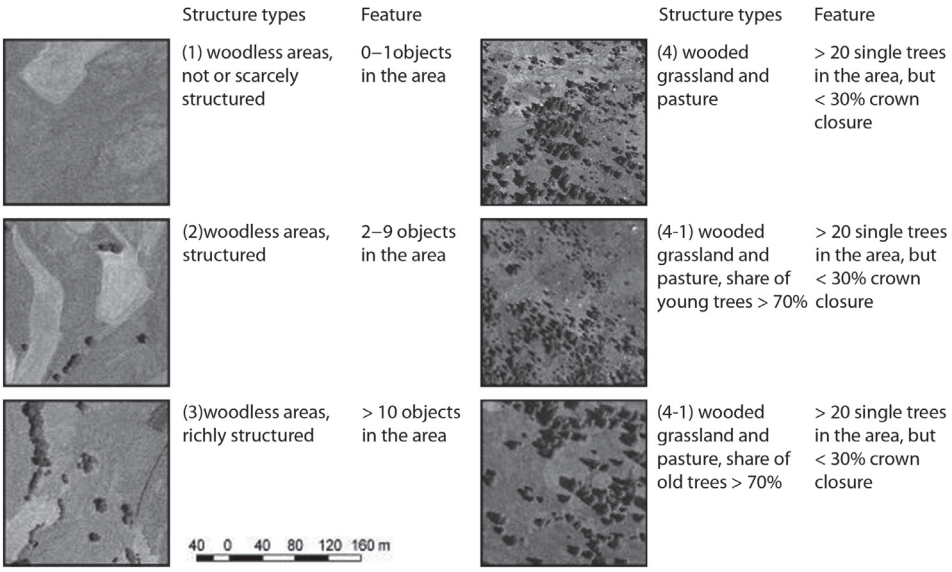

Fig. 3. Methodical classification of open, woodless areas according to their structuring degree, with concrete examples and classification features (Tasser et al., 2009).

Results

Here, we would like to present our first results from the Stubai valley study area. Using a landscape-ecological approach, a full-coverage map of landscape equipment was prepared for 1865, 1956, 1973, 1988, and 2000 (Fig. 4).

In order to validate the results from Stubai valley, additional information sources had to be found to fill the gap between 1865 and 1955. For single municipalities and single farms older data-sources on agricultural use were found. The oldest information is from 1627 (Kaas, 1930) and 1788. However, these contained only data on arable land and intensive grassland and no data on extensive grassland. For example, for Neustift i. Stubai, an increase in intensively used areas was recorded between 1627 and 1869, therefore a significant increase must have occurred during this period. Although there has been a significant change in land-use from arable land to grassland since the middle of the 19th century, changes in intensively-used areas are insignificant (Fig. 5).

According to Fig. 6 the entire agricultural area, including alpine meadows and pastures, increased by 2.300 ha from 1873 to 1961. Although the agricultural area remained more or less constant from1961, a definite highlight in agricultural land-use occurred in 1900.

How well does this statistical data correlate with landscape-ecological investigations on the basis of maps, with the analysis of aerial photos and with On-site interviews? The comparisons show great differences between these sources, and the statistical data considerably overestimates the currently used agricultural area. According to the statistical census, only

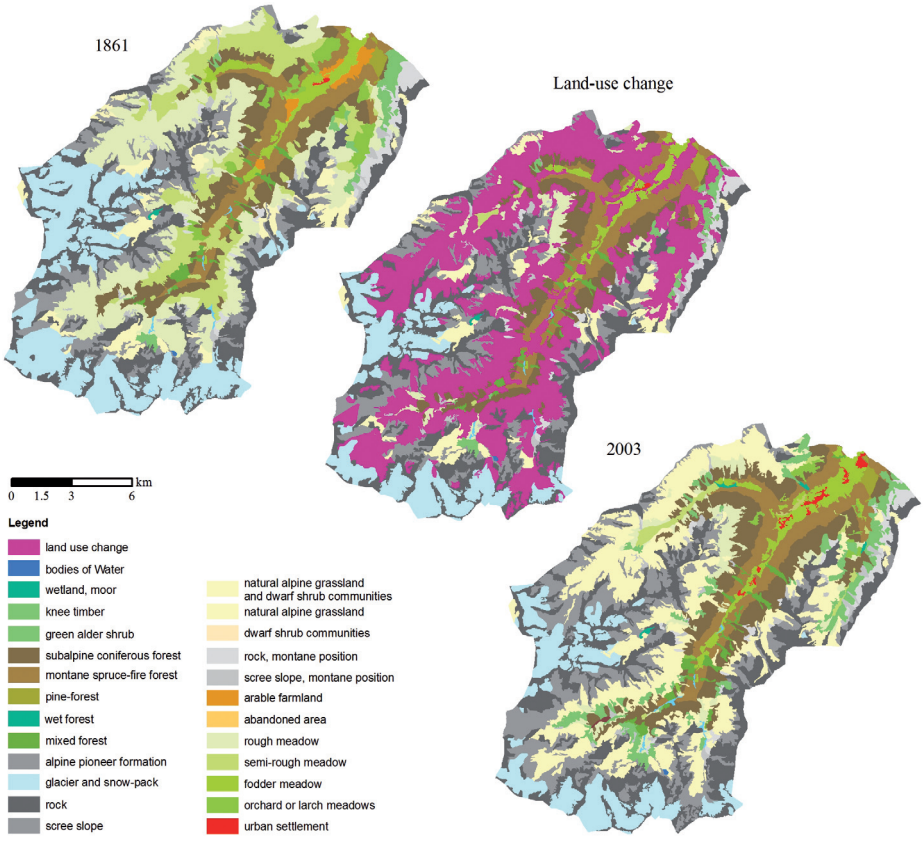

Fig. 4. Land-use changes in Neustift i. Stubai between 1861 and 2003.

a marginal abandonment of areas occurred during the last 150 years, but in reality there was a large reduction in agricultural areas. Currently, the agriculturally used area is only a third of that reported in the agricultural census of 1999 (Fig. 7). Although the statistical area-index is directly collected by the agricultural census, the owners of the farms have presumably not carried out any new area delimitation. Moreover, the potential use was most likely evaluated by current use, and therefore the landscape-ecological analysis could not be verified by statistical data.

The historical data also authenicates the following statement concerning grown arable crops in the Stubai valley. Since the 16th century the Stubai valley has been recognized as a good location for growing peas. In the middle of the 18th century the cultivation of different grain types such as barley and rye was documented. Furthermore, in the 18th century potatoes, flax, poppy and hemp were also grown.

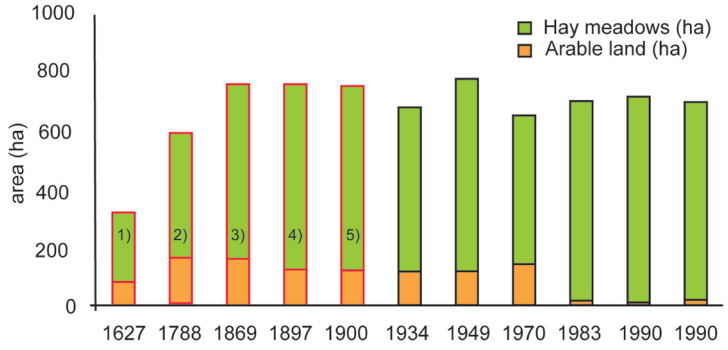

Fig. 5. Development of intensively used areas in Neustift i. Stubai. Supplements to the statistical characteristics of the different types of land use: Bars with a red border are supplements of the available historical analyses. Bars with a black border are data from the agricultural census. 1, 2) (Kaas. ca. 1930): Siedlung und Wirtschaft in einem Hochgebirgstal. Diss., Innsbruck o.J. 3) (Gesellschaft von Freunden des Stubeithales. 1891): Stubei. Thal und Gebirg, Land und Leute, Leipzig: Duncker & Humblot, 1891. 4) (K. K. Statistische Zentralkommission. 1903): Gemeindelexikon der im Reichsrate vertretenen Königreiche und Länder. K. K. Statistische Zentralkommission, Wien. 5) (Österreichisches Statistisches Zentralamt. 1949): Bodennutzungserhebung 1949. Österreichisches Statistisches Zentralamt, Wien.

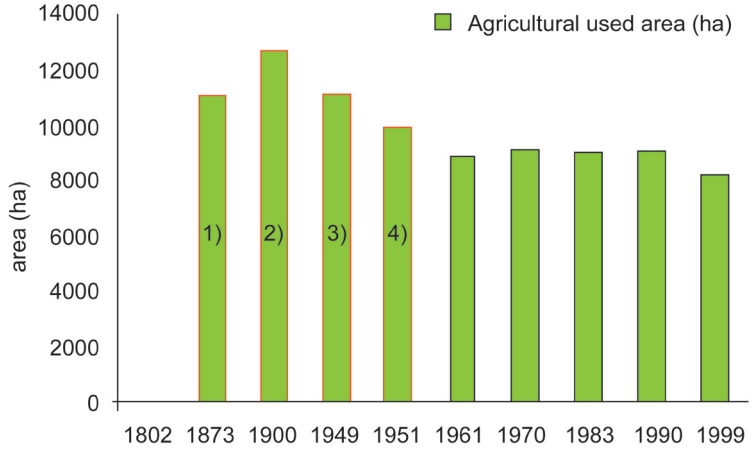

Fig. 6. Supplements to the statistical characteristics of agriculturally used areas for the entire Stubai valley. Bars with a red border are supplements of the available historical analyses. Bars with a black border are data from the agricultural census. Sources: 1) (Gesellschaft von Freunden des Stubeithales. 1891): Stubei. Thal und Gebirg, Land und Leute, Leipzig: Duncker & Humblot, 1891. 2) (K. K. Statistische Zentralkommission. 1903): Gemeindelexikon der im Reichsrate vertretenen Königreiche und Länder. K. K. Statistische Zentralkommission, Wien. 3) (Österreichisches Statistisches Zentralamt. 1949)**:** Bodennutzungserhebung 1949. Österreichisches Statistisches Zentralamt, Wien. 4) (Österreichisches Statistisches Zentralamt. 1953): Ergebnisse der Land- und Forstwirtschaftlichen Betriebszählung vom 1. Juni 1951 nach Gemeinden. Österreichisches Statistisches Zentralamt, Wien.

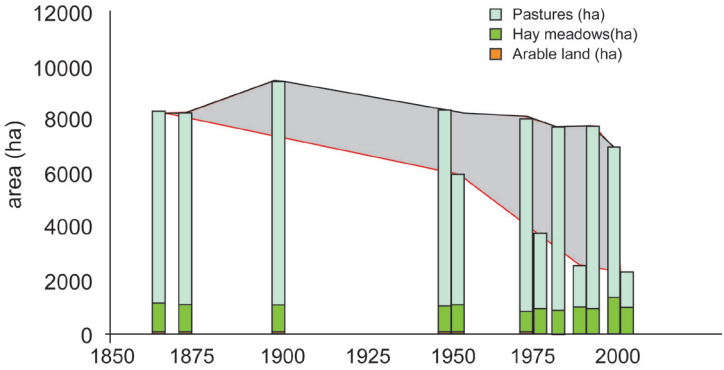

Fig. 7. Comparison of the agricultural census and the mapped agricultural area: in 1865 the different data sources are comparable, over time more and more discrepancies arise. It appears that the statistical data overestimate the real extent of agricultural areas, especially the extent of pastures.

Discussion

The conducted analysis represents the first step and this acquired knowledge can now be used to obtain results for the entire test region. Earlier studies on land-use change in the Alps and changes in agriculture revealed that different socio-economic framework conditions are decisive (Tappeiner et al., 2003; Tappeiner et al., 2008). In the 19th century the usual management form was either grassland farming or mixed farming. These traditional farming systems were also described by MacDonald et al. (2000) and in some case studies on the development of land use in mountain areas by Mottet et al. (2006) and Agnoletti (2007). While other analyses often used a smaller scale level such as municipalities (Höchtl et al., 2005; Tasser et al., 2007), our study areas were subdivided into ecoregions. This subdivision enabled detection of the development in the valley floor, distinguishing it from the development on the valley slopes (Mottet et al., 2006). Grassland farming, which is important for the production of milk and meat, currently dominates agrarian structures in the Alps (Tappeiner et al., 2003). Lower prices and higher production costs for milk and meat forced farmers to abandon unproductive and time-consuming slope regions and sub-alpine zones (Gellrich, Zimmermann, 2007). Unlike this, favorable locations in the valley floors have been intensified. However, harvest increase were recorded in Austria between 1830 and 1980, amounting to more than 150% since the beginning of industrial modernization in agriculture (Krausmann, 2001).

Outlook

Our methodical approach can now be used as a basis for creating landscape-change scenarios. Furthermore, it can be used for a complete definition of environmental and human-induced factors and it is now possible to list them in order of importance. Moreover, the detected

striking differences between the mapped land-use data and the official census-data suggest a validation of this methodical approach in the context of the national agricultural census.

This project progress will be reported continuously on our homepage (http://kulawi.eurac.edu), and in 2012 research results will be published in detailed form.

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