HERCULES
Sustainable futures for Europe’s HERitage in CULTural landscapES: Tools for understanding, managing, and protecting landscape functions and values
GA no. 603447

D3.3 Report on driving forces and actors facilitating persistence and change in cultural landscapes

Main authors:
Matthias Bürgi, Claudia Bieling, Matthias Müller

With contributions from
María García Martín, Kim von Hackwitz, Thanasis Kizos, Anu Printsmann, Juraj Lieskovský

Reviewers: Thanasis Kizos and Geneviève Girod

<table>
<thead>
<tr>
<th>Work package</th>
<th>WP3 Landscape-scale case studies (short-term history)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deliverable nature</td>
<td>Report (R)</td>
</tr>
<tr>
<td>Dissemination level (Confidentiality)</td>
<td>Public (PU)</td>
</tr>
<tr>
<td>Estimated indicated person-months</td>
<td>12</td>
</tr>
<tr>
<td>Date of delivery</td>
<td>Contractual 30.11.2015 Actual 02.12.2015</td>
</tr>
<tr>
<td>Version</td>
<td>0.1</td>
</tr>
<tr>
<td>Total number of pages</td>
<td>64</td>
</tr>
<tr>
<td>Keywords</td>
<td>Study municipality, land use/cover analysis, driving forces, actors</td>
</tr>
</tbody>
</table>
Executive summary

One of the goals of Work Package (WP) 3 of HERCULES is to reconstruct and assess the short-term changes and dynamics of cultural landscapes, using a case study approach. In this deliverable, we aim at describing and understanding how landscapes changed in six HERCULES Study Municipalities (SM) since 1850, i.e. Colmenar Viejo (Spain), Lenk (Switzerland), Börje (Sweden), Plomari & Gera (Greece), Alatskivi & Peipsiääre (Estonia) and Mobdury (Great Britain).

Whereas the description is based on the map comparison presented in D3.2, additional sources of information were needed to better understand the so called driving forces of the changes determined. We used secondary literature, statistical information and oral history interviews to assess the local historical context, the changes perceived, but also to determine which actors were influential for the changes observed.

Abandonment shows to be the most important process across all SMs included and it was especially dominant in the 20th century. Afforestation, deforestation, expansion of agriculture and intensification of agriculture were also widespread. Whereas afforestation shows an increasing trend, deforestation and expansion of agriculture show a moderate, and intensification of agriculture even a strong decreasing trend.

The SMs differ greatly regarding their average rate of change, with the fastest SM (Colmenar Viejo) showing about seven times higher rates of change than the slowest SM (Mobdury). However, all SMs depict great temporal variability of change in the course of the study period. Overall, it is interesting to note that the latest periods was in no SM showing the highest rates of change, but even included the least dynamic period in one SM (Lenk).

We also evaluate if certain factors seem to be especially suitable to cause change or persistence across the different SMs. Infrastructural developments, (macro-) economic shifts and crises, and increasing population numbers seem to have the potential to trigger massive landscape changes.

However, the specific context determines if and how such developments have an impact on the landscape. An economic crises triggering emigration, such as in the case of Lenk 1876 to 1914, might well lead to agricultural abandonment, which however in the case of pastures in harsh alpine environment might not immediately lead to forest expansion. Abandonment due to the conversion of a community structure from (subsistence) farming into commercial and industrial activities might however trigger rapid changes. Such changes can be largely facilitated by infrastructural developments, enabling easy commuting to nearby centers.

Our study reflects the diversity and complexity of landscape change processes across Europe. The number of case studies does not allow to draw general conclusions, but enables to formulate further hypotheses for research and feedback to the local communities regarding their specific development.
# Table of contents

Executive summary .................................................................................................................. 2
Table of contents ...................................................................................................................... 3
Abbreviations .......................................................................................................................... 4
1. Introduction ........................................................................................................................ 5
  2 Methodology ...................................................................................................................... 7
    2.1 Synthesizing and describing LULC changes per SM ..................................................... 7
    2.2 Assessing the driving forces ......................................................................................... 9
    2.3 Assessing the role of actors ....................................................................................... 10
    2.4 Comparative analyses .............................................................................................. 11
3 Results ................................................................................................................................. 12
  3.1 Greece – Lesvos – Plomari & Gera .............................................................................. 12
  3.2 Switzerland – Obersimmental – Lenk ......................................................................... 16
  3.3 Spain – Sierra de Guadarrama foothills – Colmenar Viejo ........................................... 28
  3.4 Sweden – Uppland – Börje ......................................................................................... 36
  3.5 Estonia – Vooremaa & Kodavere – Alatskivi & Peipsiääre ......................................... 42
  3.6 Great Britain – South West Devon - Modbury .............................................................. 50
  3.7 Comparative analysis ................................................................................................. 54
4 Discussion .......................................................................................................................... 59
5 Conclusion .......................................................................................................................... 61
References ............................................................................................................................. 62
Appendix A ............................................................................................................................ 64
Abbreviations

DF – Driving forces
GIS – Geographic Information System
KH – Knowledge Hub
LC – Land cover
LULC – Land use / land cover
OHI – Oral History Interviews
PP-GIS – Public Participatory Geographic Information System
SL – Study Landscape
SLC – Study Landscape Coordinators
SM – Study Municipality
WMS – Web Map Service
WP – Work Package
1. Introduction

The deliverable addressed the following questions:

- How did the landscape in the different Study Municipalities (SMs) change?
- What forces were driving these changes?
- What actors were influential for the changes observed?
- What factors seem to be especially suitable to cause change or persistence across the different SMs?

In recent years, a shift from documenting land change to trying to understand land change has been observed, i.e. a shift from a descriptive to an analytical approach in land change science. The study of the so-called driving forces of land(-scape) change has been promoted and influenced by various methodological contributions (Geist and Lambin 2002, Bürgi et al. 2004). Minor differences in terminology used can cause some confusion, but at the same time highlight a core characteristic of studies of driving forces of land change: They analyse an inherently scaled system. Consequently, defining the scale of the study largely determines the system and its elements.

Driving forces are the forces behind observed landscape changes, i.e., they are processes that are influential in the evolutionary trajectory of the landscape. These forces have also been called keystone processes (Marcucci 2000) or drivers (Wood and Handley 2001). The study of driving forces of landscape change has a long tradition in geography and landscape research (Wood and Handley 2001). For example, Wirth (1969) asked for a “general cultural-geographic theory of forces” and distinguished between economic forces, social forces, and public forces. More than 10 years ago, Kates, Turner and Clark (1990) concluded as final key lesson drawn from the papers collected in the volume “The earth as transformed by human action” (Turner et al. 1990) that a general theory of human-environment relationships would have to conceptualize the relations among the driving forces of human-induced change, their mitigating processes and activities, and human behaviour and organization. The driving forces form a complex system of dependences, interactions and feedback loops and they affect several temporal and spatial levels. It is therefore difficult to analyze and represent them adequately.

In many parts of the world, landscapes are being transformed at an unprecedented high rate. As a consequence, in some these regions, there is a societal demand to limit the rate of landscape change and to direct it in more desirable pathways. Insights into the causes of changes are therefore needed (Patru-Stupariu et al. online first), but additionally, direct information about impeding and stabilizing factors is also crucial. Studying landscape persistence, limiting factors and constraints to change deserves the same attention as analyzing landscape change. Persistence does not imply the absence of driving forces. For example, regulations and subsidies can counter the forces of change, and landscapes can exhibit temporal stability, i.e., persistence (Bürgi et al. 2004).

So far, three different approaches can be observed: local/regional case studies, large-scale analyses, and meta-analyses of driving forces. Whereas local case studies try to grasp the specifics of a place and its development, large-scale analyses try to overcome the well-known limitations of a case-study approach, by searching for main trends and processes over large
areas – with the drawback of not grasping the specificity of the often actor-driven changes in the land. Moreover, we might at best be able to observe some pixel-based land changes, but for sure do not grasp the wealth of dimensions addressed and summarized as landscape changes. Conducting meta-analyses is motivated by the search for general pattern, i.e. constellations of prerequisites which, if combined with a specific set of potential driving forces, results in a at least somehow predictable change of the landscape. Such pattern would then be seen as contributions to a theory of land change. However, such meta-analyses are limited by the diversity of approaches applied and data used in the case studies included. Additionally, the distribution of the case-studies found does hardly reflect the diversity of the system under study in a meaningful was, as they were not planned and conducted with the aim to be representative for a larger area, but with specific interests for a specific location or landscape.

What is lacking so far is a comparative study of land changes based on case studies which have been conducted with exactly this comparison in mind. Such an effort faces several challenges, due to the variability of source availability and also the land-use systems considered, and pragmatic solutions have to be found to define common protocols for data evaluation, acquisition, and analyses. Work package 3 from HERCULES offers the unique opportunity to conduct such a comparative study. WP3 aims at reconstructing and assessing the short-term past changes and dynamics of cultural landscapes, using case study approach.

The WP3 first task was to select six diverse, representative, and understudied cultural landscapes across Europe:

- Greece: SL Lesvos / SM Plomari & Gera.
- Switzerland: SL Obersimmental / SM Lenk.
- Spain: SL Sierra de Guadarrama foothills / SM – Colmenar Viejo.
- Sweden: SL Uppland / SM Börje.
- Great Britain: SL South West Devon / SM Modbury.

Prime data sources regarding landscape changes are historical maps and remote sensing data. Standards of how to handle these sources and produce homogenous data series are well established. It remains questionable, however, to which degree the resulting map series actually stand for landscape, or if they do not simply reflect land cover, or at best land use. For the analysis of driving forces, no similar standards have been established. We decided to supplement the usual range of information taken from secondary literature and historical statistics on e.g. population and cattle with standardized oral history interviews. By doing so, we are able to explicitly include an actors perspective in the analysis, which we see as novel and innovative. As the SM Modbury was added later, we were not able to conduct oral history interviews in the SM so far, and the deliverable only includes the information derived from the map analysis. It is however foreseen to publish a paper on the results presented in this deliverable, in which the OHIs for SM Modbury will also be included.
2 Methodology

The LULC change analysis used in this deliverable has largely been described and reported in D3.2 “Compiled timelines of cultural landscape change for the study landscapes”. Additionally, were added Modbury, i.e. a SM which was originally foreseen as a WP3 SM (see D 3.1 “List and documentation of case study landscape selected for HERCULES”), but later on had to be removed from the list due to temporary data acquisition problems.

The size of the SMs selected ranged from 24 to 208 km² (Table 1), which has to be considered in comparing e.g. absolute rates of change or population numbers.

Table 1. The characteristics of study landscapes (SL) and study municipalities (SM).

<table>
<thead>
<tr>
<th>Country</th>
<th>Study Landscape</th>
<th>Area (km²)</th>
<th>Study Municipality</th>
<th>Area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greece</td>
<td>Lesvos</td>
<td>1’638</td>
<td>Plomari &amp; Gera</td>
<td>208</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Obersimmental</td>
<td>334</td>
<td>Lenk</td>
<td>123</td>
</tr>
<tr>
<td>Spain</td>
<td>Sierra de Guadarrama foothills</td>
<td>835</td>
<td>Colmenar Viejo</td>
<td>184</td>
</tr>
<tr>
<td>Sweden</td>
<td>Uppland</td>
<td>17’988</td>
<td>Börje</td>
<td>47</td>
</tr>
<tr>
<td>Estonia</td>
<td>Vooremaa &amp; Kodavere</td>
<td>1’917</td>
<td>Alatskivi &amp; Peipsiääre</td>
<td>160</td>
</tr>
<tr>
<td>Great Britain</td>
<td>South West Devon</td>
<td>6’707</td>
<td>Modbury</td>
<td>24</td>
</tr>
</tbody>
</table>

In the following a brief overview of the methodology applied will be given, distinguishing the following steps:

-Synthesizing and describing LULC changes per SM
-Assessing the driving forces
-Assessing the actors
-Comparative analyses

2.1 Synthesizing and describing LULC changes per SM

Compiling comparable LULC data across many different regions and across time, based on highly heterogeneous historical and contemporary topographical maps is a very challenging task. The basic data used for the LULC analysis performed have been described and presented in HERCULES Deliverable 3.2 “Compiled timelines of cultural landscape change for the study landscapes”. However, an additional round of quality control revealed certain shortcomings for the SM in Estonia, Greece and Switzerland. Applying cleaning procedures and in some cases new digitalisations were necessary to reduce the risk of introducing artefacts especially for the comparative analysis. Consequently, the data presented in this deliverable might in some cases differ slightly from the ones included in D3.2. As mentioned, Modbury was additionally included in the analysis.
The revised GIS data were summarized in bar graphs on legend level 1, which ensures comparability across all SM, and legend level 2, which reflects the specific LULC classes for every SM specifically in more detail. Map series on legend level 2 were updated to depict the spatial distribution of LULC changes.

To assess LULC per SM, we distinguish between developments, changes and processes:

*Developments* were changes in proportion of one specific LULC category.

*Changes* were defined as specific changes between two categories, be it on legend level 1 or 2 – e.g. from “3.1 Meadows and pastures” to “7.1 Natural rock” (Table Appendix A). For every SM and all study periods the 10 largest absolute changes regarding annual aerial change (ha/y) and all relative changes surpassing an annual rate of 0.1% were assessed. By doing this, we were able to detect the most relevant changes in terms of impact on the SM as a whole, but also LULC changes, which happened at high annual rates, but did not affect large areas (e.g. urbanization).

*Processes* were defined as overarching trends in LULC, such as urbanization, agricultural abandonment, or deforestation. Processes were calculated based on the changes (see Table 2). For example all changes which converted any type of LULC class into “1 Urban/built-up” were summed up to result in a figure for the process “urbanization”. The same change can contribute to two processes: if forest areas have been converted into settlements, this area is not only contributing to the process “urbanization”, but at the same time also seen as a contribution to the process “deforestation”.

Table 2: Changes between LULC categories on legend level 1 are summed up into a defined set of processes (details see text).

<table>
<thead>
<tr>
<th></th>
<th>A1 Urban/Built-up</th>
<th>A2 Agriculture</th>
<th>A3 Grassland and shrubs</th>
<th>A4 Forest</th>
<th>A5 Wetlands</th>
<th>A6 Water</th>
<th>A7 Bare land</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 Urban/Built-up</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2 Agriculture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3 Grassland and shrubs</td>
<td>Abandonment &amp; Urbanization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4 Forest</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5 Wetlands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A6 Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A7 Bare land</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Distinguishing between changes and processes enabled to grasp the specific LULC change, but also synthesize the changes into entities, on which driving forces often act, such as the demand for housing, which might not be specific regarding originating LULC class.
What is called processes in this study, also has been called proximate causes of LULC in other analyses, e.g. by Geist and Lambin (2002), who distinguish between proximate causes and underlying driving forces of tropical deforestation. As we are not focusing on one specific aspect of LULC change, but aim at assessing and understanding landscape dynamics as a whole, we prefer to specifically talk about processes, which are general enough and widespread to affect landscapes across Europe or even the Globe.

To summarize the most important developments, changes and processes as a base for the analysis of driving forces and actors, short narratives were compiled by SM for every study period.

2.2 Assessing the driving forces

Information about the forces driving the developments, changes and processes determined by SM and period were extracted from the oral history interviews (OHI), timelines of important events with potential impact on LULC per SM and statistical information. All this information was compiled by the SLC of the respective SMs. To ensure as homogenous information as possible from all SM, detailed instructions regarding the compilation of the timelines (primarily based on secondary literature), the statistical information, and especially the OHIs were distributed early on in the project. For the OHIs, a minimum of six interviews with long-term residents of the SM (or the SL, assuming that the relevant driving forces were of regional importance) was required. The interviewees should preferably be old enough to have first-hand memories of land use and landscape change in the SM of a greater time horizon (e.g. 50 years back). An equal representation of gender was foreseen, as well as an adequate representation of the diversity of roles and perspectives on the landscape, such as farmers, foresters, teachers, community officials, ordinary people, and local historians.

The interviews included a section on the personal background of the interviewees, followed by questions regarding the personal perception/remembrance of local landscape change, and the related driving forces. If possible, all OHIs were recorded and transcribed. To make best use of the scarce PM for the SLC, no translation and full transcripts were required, but only targeted information of use for the analysis of driving forces and actors was compiled in transcripts in English.

Based on the list of potential driving forces compiled, plausible driving forces for the aspects mentioned in the narratives were compiled as short paragraphs.

To make best use of the expertise on the local conditions the SLC gained by collecting all this information, the chapters compiled for this deliverable on the SMs (on LULC changes, driving forces, and actors), were all checked and corrected by the respective SLC. This additional round of feedback resulted also in some further information from the OHIs, which had not been transcribed, but provided later on.
2.3 Assessing the role of actors

For assessing the role that actors play in land change, we followed the conceptualization of actors proposed by Hersperger et al. (2010). In line with that, we focused on those actors that are directly affecting processes, and excluded indirect effects, e.g. when actors influence driving forces which result in change processes. For instance, farmers that convert their land to new types of land use would be considered, but not a forest agency that establishes forest protection guidelines that prevent logging/forest decrease.

For classifying the actors, we used the following criteria:

- organizational types (individuals, agencies at different levels, NGOs)
- scale (local, regional, national, supranational)
- from within the region/outsiders
- sectors (farming, forestry, tourism, local households,…)

Moreover, we considered to two dimensions of action that is relevant in terms of land change. Firstly, for the type of influence we distinguished between active influence (a person or group actively doing something) and passive influence (a person or group stopping to do something or reducing activities). Secondly, we had a closer look at the type of effects of action. Here, we have activities triggering or accelerating change on the one hand, and activities impeding or slowing down change processes on the other hand. The possible combinations of different types of influence and effects are shown in Table 3, along with some illustrative examples.

Table 3: Changes between LULC categories on legend level 1 are summed up into a defined set of processes.

<table>
<thead>
<tr>
<th>ACTORS</th>
<th>Type of influence</th>
<th>Type of effect</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actively (doing something)</td>
<td>Passively (stopping to do something or reducing influence)</td>
</tr>
<tr>
<td><strong>Type of effect</strong></td>
<td><strong>Triggering or accelerating change</strong></td>
<td><strong>e.g. Converting arable land into grassland</strong></td>
</tr>
<tr>
<td><strong>Impeding or slowing down change</strong></td>
<td><strong>e.g. Removing woody species from pastureland</strong></td>
<td><strong>?</strong></td>
</tr>
</tbody>
</table>

For reviewing the role of actors, we used the same information and approach like for the driving forces assessment. Oral history interviews (OHI), timelines of important events with potential impact on LULC per SM and statistical information served as data basis; furthermore, the insights from the driving forces analysis were considered. Where necessary, e.g. in case of doubts or open questions, local SLC were contacted, in order to finally contribute short paragraphs on the role of actors specifically for each SM included in this report.
2.4 Comparative analyses

We were interested in finding out what the dominant processes across all study regions were, and if shared pattern in the development of these processes could be determined. To take the different timing of the available maps into account, the period from 1850 to 2012 was divided up into six 25-year periods and one last 12-year period, and for all these periods and SMs, the processes were ranked based on the numbers most closely tied to the period. Rank sums for all SMs and all periods were calculated and the most important processes across all SMs determined.

To determine periods of high persistence and high change, all yearly changes determined by period and SM were summed up (legend level 1 and legend level 2 separately). To be able to compare these rates between different SMs, the values were normalized by the total area of the SMs. For all SMs, the periods with the highest and the lowest total rates of change were determined and the related driving forces and actors compiled and discussed. This comparison had to be restricted to aspects visible on legend level 1, as otherwise very dissimilar data situations would have been put on the balance.
3 Results

3.1 Greece – Lesvos – Plomari & Gera

Land use/Land cover changes

![Figure 3.1.1 LULC changes in Plomari & Gera on legend level 1](image1)

![Figure 3.1.2 LULC changes in Plomari & Gera on legend level 2](image2)
Figure 3.1.3 Mapped LULC changes in Plomari & Gera on legend level 2
Development, changes, processes

During this period, we see a high dynamic between perennial agriculture and forest: The most important change was the conversion of perennial agriculture to forest (31.71ha/y), but forests were also converted into perennial agriculture at a rate more than half as high (17.97ha/y). Perennial agriculture was also converted into wooded grassland and shrubs (12.76ha/y). The latter showed the biggest relative increase, as additional forest was converted into wooded grassland and shrubs (7.79ha/y). Other processes, such as the conversion of perennial agriculture into urban areas (1.63ha/y) were of much less importance.

Consequently, the proportion covered by perennial agriculture decreased from 67.87% to 60.87% and wooded grassland and shrubs increased from 7.66% to 12.85% of total land cover.

Abandonment (34.17ha/y) and afforestation (32.28ha/y) were the dominant processes, followed by deforestation (26.23ha/y), expansion of agriculture (25.76ha/y) and extensification of agriculture (13.82ha/y).

Source critical remark: During the digitalization processes it was difficult to correctly distinguish between forests, olive groves (perennial agriculture) and wooded grasslands and shrubs. This might have contributed to the rather high turn-over rates between these categories.

Driving forces and actors

The subsequent statements are based on a manuscript by Iosifides (in prep.).

- Former dominance of olive oil plantations: The former olive landscapes was densely stocked (over 2,000,000 trees in 1961).
- Reasons for decline in oil farming: the low price levels of olive oil, intensity of production (because of the lack of technological and other means of production and the extreme difficulty of access to the fields due to the lack of central and rural roads). This led to very harsh economic and social conditions of the past.
- Subsequent abandonment of olive farming and gradual destruction of terraces. Also triggered by a lack of cooperation and trust between farmers for which they blame external factors such as lack of efficient policies. But also educational advancement of the youth, i.e. young people moving away from the farming profession and towards education despite limited prospects for employment of young people in general due to economic crisis. The unwillingness of locals and especially the youth to engage with the farming profession gives a larger role to immigrants in cultivating the land.
- The remaining olive farming is characterized by increasing mechanization of farming activities (new technologies), and the intensive use of fertilizers and other chemical substances. Despite the negative evaluation of the use of chemicals and mechanization in the present era, respondents note that those developments co-exist with a significant turn towards organic production, mainly of olive oil.
- Additional factors/events:
  - Critical events such as extended fires – for example the fire in the areas of Karionas, Neochori, Sedounta and Agiasos in 1994 which destroyed 35,000 str. of pine trees – are stressed as crucial factors for significant landscape change.
  - Climate change
  - The decline of Lesvos as industrial center of the past and to the closure of soap or fertilizer industries due to various reasons such as the demise of Ottoman Empire and intensive competition from other areas.
  - A series of research participants has to do with infrastructural improvements mainly road and port transport.
  - Intensification of stockbreeding which leads to overgrazing.
Deliverable D3.3

From timeline/statistics:
- 1961-2011: Population declined from 19’626 to 11’602 (numbers for Plomari & Gera)
- 1961-2000: Number of farms declined from 5’964 to 3’013 (same)
- 1961-2000: Area covered by tree crops declined from 10’919.6ha to 9’428.14ha.
- Comparing the numbers for perennial agriculture derived from the map analysis (1960: 14’144ha / 2012: 12’684ha -28.1ha/y) with the statistical data for the area covered by tree crops (1961: 10’919.6ha/2000: 9’428.14ha/-38.24ha/y) reveals a reasonable match in extent and development. Based on this we can say (what we actually knew before…), that perennial agriculture in this SM is largely dominated by olive plantations.
- 1960: Increase in olive oil production.
- Since 2000: Increase in settlements along the coast.

Interpretation driving forces:
The major changes visible in the map analysis happened in categories which were hard to map. The statistical numbers reveal a decline in population and numbers of farms, with a much lower reduction in area covered by olive plantations. Rural depopulation is obviously widespread and the younger generation is seeking more profitable employment. Structural limitations, such as the labor-intensive terraces and the limited accessibility due to the rugged terrain, make olive farming even less attractive. The reported increase in settlement along the coast so far has not left major traces in land cover – the increase in urban land cover from 3.33% to 3.78% still reflects this trend.

Interpretation actors:
Farmers, or more generally a rural population being engaged in farming activities, are the prime actor group for this area. The number of people accounting for this group drastically decreased, both due to outmigration and a moderate trend towards bigger agricultural enterprises. Along with this qualitative changes are reported: People managing land are more and more the elderly part of the population, new management practices are upcoming, like intensive livestock breeding or the increased use of pesticides. Moreover, entirely new types of actors, like those settling along the coast, are gaining influence. However, the latter developments are not revealed by the LULC maps (yet). The major change processes displayed – abandonment and afforestation as well as deforestation and expansion of agriculture – mirror a bifurcation of people withdrawing from farming in many cases on the one hand and the remaining actors applying more intensive / new practices on the other hand.
3.2 Switzerland – Obersimmental – Lenk

Land use/Land cover changes

Figure 3.2.1 LULC changes in Lenk on legend level 1

Figure 3.2.2 LULC changes in Lenk on legend level 2
Figure 3.2.3a Mapped LULC changes in Lenk on legend level 2 for 1840 – 1935.
Figure 3.2.3b Mapped LULC changes in Lenk on legend level 2 for 1968 – 2013 (legend see Fig. 3.2.3a).
1840 - 1876

**Development, changes, processes**

During the first period, meadows and pastures were converted into forests (15.22ha/y) and into natural rock (6.67ha/y). Also glaciers retreated at 7.67ha/y, but half of this change was compensated by the reverse, i.e. natural rock to glaciers at 3.72ha/y, both classes being part of legend level 1 class “bare land”. Consequently, abandonment and afforestation were the most important processes at rates of 15.35ha/y and 15.3ha/y respectively.

Source critical comment: The relative high persistence of LULC and the persistence of the trends starting during this first study period underlines the quality of the maps used. However, in the map of 1840 (Dufourkarte – Fig 3.3.3) forest area seemed to be depicted with less details than in the subsequent maps. The afforestation during this first period therefore might be partly due to these mapping differences, i.e. persistence of LULC might even be higher than assessed.

-> **What was triggering the conversion of meadows and pastures during this and the following period into mainly forests, but also natural rock?**

**Driving forces and actors**

*From OHI:*

- No information reaching back so far.

*From timeline/statistics:*

- 1846 - 1870 population decreased from 2'393 to 2'311 (BERNHIST)
- 19\(^{th}\) ct: The residential population of the Lenk decreases from 2369 to 1748 during the 19\(^{th}\) century. Emigrations contribute noticeably to this development. (Bannwart 1999)
- 1850s: The 1850s see another wave of emigration. 1845 the late blight of the potato has reached the Simmental and during the 1850s, several cold springs and rainy and wet summers have led to crop failures and rising grain prizes. Since the year 1851 the canton of Bern subsidises communities to facilitate the emigration of willing people. The share of emigrants from the Obersimmental is relatively high. The emigration of whole families is frequent. (Pfister 1995)
- 18./19. Ct: In the course of the modernization of agriculture the Swiss lowlands begin to keep more livestock and start to make their own cheese. As the cheese from the Alps of the Obersimmental cannot compete with this cheap cheese, the Obersimmental focuses its agriculture on the breeding of breeding cattle (Simmental cattle). The cattle are mainly exported to the Swiss lowlands and southern Germany. (Pfister 1995, Imobersteg 1919)
- 19\(^{th}\) ct: In the 19\(^{th}\) century several floods occur in Switzerland. With time people realise the the floods are caused by the large deforestations in the mountains. Subsequently logging requests are only granted if the protective and provision function of the affected forest isn’t impaired.(Pfister 1995)
- 1862-1914: Several hotels are built to accommodate rich guests, such as industrialists, state officials, business people and professional classes. Thus the bath of the Lenk is expanded in 1862.
- 1862-1912: Since the opening of the spa 1862 in the village of Lenk a one-horse diligence runs daily between Zweisimmen and Lenk. Since 1874 the diligence drives twice a day and since 1897 three times a day.(Bannwart 1999)
Interpretation driving forces:

Weather- and pest-induced crop failures, and an increasing competition from lowland cheese factories made the economic situation difficult, triggering emigration and a slight population decline. This might have reduced the available workforce for maintaining pastures, i.e. removing of bushes/young trees, but also of stones coming down from the rocky slopes. Consequently, abandoned pastures turn into forests or natural rock. Of course, this statement is again based on the assumption that natural rock was depicted with the same precision in the Dufourmap, compared to the later map series (see source critical remark above). The retreat of the glaciers might have been caused by the end of the little ice age at around 1850.

Interpretation actors:

In this period, human impact has been on abandonment of meadows and pastures and subsequent natural reforestation, but not on changes affecting bare lands (relative changes of natural rocks and glaciers). The principal actors driving changes are farmers, which do not take an active role in this, but rather passively withdraw from farming practices. The tourism sector may also have some influence by providing economic opportunities for farmers and thus preventing further/faster abandonment; however, this is more of a reasoned speculation than a statement that can be backed up with substantial data.

1876 - 1914

Development, changes, processes

Much smaller changes and rates were observed in the subsequent period. None of them are worth mentioning.

-> A phase of persistence – what might be the reasons for this?

Driving forces and actors

From OHI:
- No information reaching back so far.

From timeline/statistics:
- 1870 - 1910 population decreased from 2’311 to 1’757 (BERNHIST)
- 1871: After a federal decree of 1871, and the release of the Swiss Federal Forest Law in 1874, reforestations in alpine regions are subsidised. This leads to vast reforestations since 1875 (Schuler et al. 2000)
- 1878: A fire destroys the whole centre of the village Lenk. 17 residential houses, amongst them 5 guesthouses, 7 barns, 2 forges and the church burn down. (Bannwart 1999) After the fire which destroyed most of the village in 1878, the first major luxury hotels aside from the bath, such as the hotel Bellevue (1906) and the hotel Wildstrubel (around 1900) are built. (Bannwart 1999, Egli 2000).
- 1880: In the 1880s again many people emigrate. The economic situation and rising foreign competition has led to sinking prizes for exported cattle. Therefore some farmers are no longer able to pay the increasing interest of their loaned money. Many people emigrate to the United States of America. Some emigrate to other Swiss cantons where they replace people working now in the Industry as farmers. (Pfister 1995)
- 1885: The economic situation and the growing foreign competition lead to sinking prizes for exported cattle. Some farmers are no longer able to pay the increasing interest of their loaned money (Pfister 1995)
− 1896-1902: Extension of railway line to Zweisimmen (Bannwart 1999).
− 1905: railway line Zweisimmen-Montreux. This railway line is mainly built for tourists. It is driven electrically from the beginning. (Bannwart 1999)
− 1910-1912: railway line Zweisimmen-Lenk. This narrow gauge railway line is driven electrically from the beginning. It is mainly built for tourism. (Pfister 1995)
− 1900-1920: crisis of the hotel business as rainy summers and winters with little snow lead to few tourists, many hotels cannot pay the interest rates on their bank loans any longer and get into debt. The outbreak of war, which leads to much lesser holiday guests precipitates a crisis for the hotel business. (Pfister 1995)

**Interpretation driving forces:**
The accelerated decline in population reflects ongoing economic challenges, to which the fire of 1878 and the economic crises of the 1880s also contributed.

**Interpretation actors:**
For this period, no changes regarding actors and their influences can be identified: We see a continuation of abandonment due to declining farmland management activities; however, a critical maintenance level obviously could be kept and thus impeded faster changes.

**1914 - 1935**

*Development, changes, processes*
Also this period was relatively stable. The largest change was the conversion of meadows and pastures to natural rock (8.00ha/y), to wooded grasslands and shrubs (7.06ha/y), and to forests (2.79ha/y). Consequently, the process disturbance/rockfall/other was dominating at 8.01ha/y.

-> *The phase of relative persistence continued – what might be the reasons for this?*

**Driving forces and actors**

*From OHI:*
− Wild hay making was very important before 1945. Wild hay was in demand and one could make money with it. After the war this stopped abruptly (HZ)

*From timeline/statistics:*
− 1910 - 1930 population decreased from 1’757 to 1’750 (BERNHIST)
− 1913/14: the region “Neufeld” in the south of the village of Lenk is drained and the Lenkerseeli (small lake about 1 km south of the village Lenk) is created. (Bannwart 1999)
− 1900-1920: crisis of the hotel business as rainy summers and winters with little snow lead to few tourists, many hotels cannot pay the interest rates on their bank loans any longer and get into debt. The outbreak of war, which leads to much lesser holiday guests precipitates a crisis for the hotel business. (Pfister 1995)
− 1923: the alp Iffigen is sold 1923 to a cooperative from Biglen - a village in the lower parts of the canton of Bern. As export of cheese from the Swiss lowlands becomes difficult as a consequence of protective duties in neighbouring countries and rising foreign competition, the Swiss lowlands start to breed breeding cattle. This leads to the summering of cattle from the lowlands on the Alps of the Bernese Oberland. Several Alps of the Bernese Oberland are sold to cooperatives from the Swiss lowlands. (Bannwart 1999, Imobersteg 1919)
Interpretation driving forces:

Population numbers remained stable, at a level below e.g. 1798 (1808). Alpine agriculture was still affected by export problems (cheese and cattle), despite early attempts to increase productivity (drainage). The increase of natural rocks on former meadows and pastures reflects the accentuated decline of working hours put into pasture maintenance. Efforts to increase tourism by new hotels and improving the infrastructure were severely dampened by World War I.

Interpretation actors:

Also for this period, there is a continuation of farmers’ influence on land change. This means the abandonment due to declining farmland management activities is ongoing, but again a basic level of maintenance activities could be kept and thus impeded faster changes. Contributing to this could be the influence of actors external to the region, like lowland farmers starting to use the mountain pastures for summering of cattle. With this, for the first time actors from beyond the region had direct influence on local land management.

1935 - 1968

Development, changes, processes

Forests almost doubled their size at a rate of 27.22ha/y on meadows and pastures. Meadows and pastures only partially compensated this loss by expanding on wooded grassland (2.34ha/y) and on forests (2.06ha/y). Glaciers retreated rapidly at 10.50ha/y.

The most important process was agricultural abandonment (30.61ha/y) and afforestation (30.52ha/y).

Source critical comment: Change of map series! Given that the development was lower before and after the change in map series, at least the height of the rate might have been caused by this artefact.

Driving forces and actors

From OHI:

- Wild hay making was very important before 1945. Wild hay was in demand and one could make money with it. After the war this stopped abruptly (HZ)
- A lot of forest was destroyed by the Föhn storm in 1962 (but might have remained in the forest class) (PZ – also HZ)
- Construction of secondary residences started slowly in the 1960s (HZ)
- Lenk was the first municipality of the Bernese Oberland with a zoning plan. This was because of the planned motorway (HZ)
- When my father was farming I thing in the sixties the community needed to make a zoning plan and the authorities just asked who would like to have some building area. This was a disaster. Then the building industry got a momentum and luckily there are the cantonal authorities because the local authorities could do nothing to slow down building activities. Everybody in the village had some benefits from the building industry and so it is impossible to stop it. (HA)
- Farmers were also responsible for big building areas, as when zoning plan was made most of them wanted to have building area around their farms to be able to build more houses around (for their children). (PS)
From timeline/statistics:

- 1930 - 1970 population increased from 1'750 to 1'876 (BERNHIST)
- 1930s: As a consequence of the world economic crisis during the 1930s, less rich foreign tourist come to visit the Bernese Oberland. Instead, middle class people from northern Switzerland come to spend their holidays in the mountains. As they cannot afford staying in hotels, the demand for holiday homes increases and new holiday homes are constructed both within unused huts and as new buildings. (Egli 2000)
- 1937/8: In the winter 1937/38 the first cable railway, the “Funi” - a mixture between a sledge and a cablecar - is opened.
- 1930-1945: The main road of the Simmental is extended to 6m width. Its position isn’t altered. (Bannwart 1999)
- 1940: Due to the upcoming artificial insemination the trade with breeding bulls disappears. Cattle markets are replaced by cattle exhibitions. (Aeschlimann 1978)
- 1950s: The main process of mechanisation of agriculture of the Obersimmental takes place not until the end of the Second World War. After the Second World War, more and more machines are used in the agriculture of the Obersimmental. In the valley bottoms, loader wagons, rotary tedders and pressure tanks for liquid manure are used. Upon the mountains, motor mowers and single-axle tractors are spread. The single-axle tractors are replaced since the 1970s by four-wheel tractors and transporters. The first milking machines are used, driven with petrol engines. (Bannwart 1999)
- 1950s: After the Second World War, the making of “wild hay” on meadows inaccessible for livestock is often given up. “Wild hay” is being replaced progressively with bought concentrated feed. (Aeschlimann 1978)
- 1950: The number of holiday homes in the village of Lenk increases very much in the second half of the 20th century. After 1980 the increase in holiday homes attenuates slightly. Meanwhile the number of unrented second homes increases. (Bannwart 1999)
- 1950s: In the second half of the 20th century, many cable railways are built in the community of Lenk. (Lenker Bergbahnen 2014)
- 1951 - : Purchase of agricultural products is guaranteed. The state guarantees salaries for farmers that equal those paid in the industry through the regulation of prizes. Combined with a stagnating demand this leads to overproduction. (Schmid et al. 2012)
- 1955-1975: From 1955 to 1975 the number of farms in the village of Lenk decreases a lot. Meanwhile the share of part-time farms, the farm size and thereby livestock increase. (Bannwart 1999).
- 1962/1967: A total of 1466 ha forest is damaged. Around 6.3 million of plants are used for reforestation. (Aeschlimann 1978)
- 1950: To enable the use of motor vehicles in agriculture, vehicle-access roads are built on the mountains of the village of Lenk. Between 1950 and 1960 a road leading from the village to the Bühlberg and to the Metsch is built. Afterwards the roads Aegeten-Wallbach-Haslerberg, Pöschnried-Pöris, Guetebrunnen-Guggernäll, Simmenfälle-Rezliberg and others are constructed. The increased use of asphalt in road-building makes the mountains accessible to cars. (Bannwart 1999).

Interpretation driving forces:

Despite the degree of changes recorded might be partly due to the change in map series used, this period encompasses the economic boom period following World War II. Winter tourism was promoted and second home construction started after the war. Agriculture was on one hand intensified (mechanization & motorization), but labor intensive activities, such as wild hay making on steep slopes, were abandoned. State-guaranties for prices for agricultural products, and more directly subsidies for road construction and afforestation projects left their marks in the landscape. Part-time farming in combination with employment in tourism was attractive. Land owners, i.e. farmers, saw a profit from selling construction plots and/or second homes.
The rapid retreat of the glaciers during this period is in line with the findings of Glur et al. (2015) who show that glaciers melted from around 1850 on, triggered by the end of the so-called Little Ice Age.

**Interpretation actors:**

Farmers continued to be the main actors driving land change (and persistency), by a combination of intensification (motorization, increase of livestock numbers) and extensification practices (abandonment of less accessible pastures, afforestation). It can be assumed that in this period there was less “unplanned” abandonment (due to emigration) and corresponding gradual forest encroachment, and more intended action (planned afforestation by community and state, supported with federal subsidies).

Activities carried out both by farmers and external actors (investors and/or individuals purchasing land for building secondary residences and tourist homes) prepared future increases in built up areas; with this we have clear sign of direct influence of external actors on local land change processes.

**1968 - 1992**

**Development, changes, processes**

The retreat of the glaciers was the most important change (4.67ha/y), followed by the continuation of forests expanding on meadows and pastures (2.65ha/y). This period also shows the largest increase in urban areas, which expanded at 1.86ha/y on meadows and pastures.

Abandonment (5.46ha/y) and afforestation (3.77ha/y) continued to be the most important processes, followed by the expansion of agriculture (3.47ha/y). Also deforestation took place (1.97ha/y). Urbanisation remained relatively minor (1.86ha/y).

- > What is causing the glaciers to melt? And meadows and pastures to be abandoned?

**Driving forces and actors**

*From OHI:*

- 20 to 30 years ago, there was always some firn left in summer. Today, there is no more firn, only sometimes under the Wildstrubel (PZ)
- Silos. That’s what annoys me in the landscape. That destroys the landscape (PZ)
- The Lenkersee was unsilted because it was almost filled up (PZ)
- The forest area did not change a lot, but the forests became denser (PZ)
- People build secondary houses with the money from their retirement funds (PZ)
- A lot of access roads to alps were built (SZ)
- Construction of connection roads to alps is a change that is noticeable in the landscape (EZ)
- Tourism led to the construction of a lot of new buildings and cable cars (SZ)
- Forests did not really change, maybe there are more bushes. In some parts there are Alpenrosen growing and when nobody cuts them, the meadows cannot be used anymore (SZ)
- Formerly the farmers stayed on the alps and could cut bushes between milking the cows and cheese making. Now they don’t cut the bushes anymore, but they come back to the valley (SZ)
- About half of the secondary residences were built as tax-privileged investment. The other half was build for touristical reasons (HZ)
- Construction of secondary residences and the building zones have an important influence on the landscape (EZ)
It is important that the motorway to Zweisimmen was not built. This would have changed the landscape a lot (EZ)

Plans for the motorway were declined by the public in the 80ties. The Pro Simmental association fought against the motorway (HZ)

The street to the Metschbahn was built in the landscape in a brutal manner. It is questionably if it’s going to be removed again. Similarly the street for the construction of the Wallegbahn also stayed although it should have been removed (HZ)

Is it possible that forest expanded in the middle altitudes? And is it possible that farmers let their cows graze there for a shorter period? Yes, this is exactly the case. The cattle are longer in the valley and longer on the Alps but only for a shorter period at a middle elevation (HZ)

This is due to the failed farming policies. When the subsidies were given per livestock unit farmers used to have too many cows for the surface of their farm. Now the subsidies are calculated per surface of the farm and this is much better. And the farmers build big stables around near the village corresponding farm land. The goal was to later get more land by incorporating land from other farms. And the farms today are bigger? Yes, and that is why some land is overgrown with bushes. Farmers cannot look after the whole area anymore and do not farm the steep slopes anymore (HZ)

Some single trees and hedgerows were certainly removed because of mechanization of farming. Especially the access roads were widened. This was also subsidized by the Meliorationsämter (HA)

Lenk was a tourist region since I remember. Building activity begun in the sixties and accelerated until the seventies and eighties where the biggest buildings were built. (PS)

There is a lot more traffic. Private and also farmers are driving a lot. When I was a child nobody had a car. Now all the young people have a car when they get 18 years old. (PS)

What do you think of these changes? For example that the forest did expand especially in the mid-level altitude. These changes are real. But if you are living here you maybe do not really see it. It is a slow process. If you would go away and come back after 5 years it would be obvious. Farming infrastructure and motorization changed also a lot. Today farmers have huge stables instead of several small buildings. And some farmers drive dozens of kilometers to dung their fields as they have to bring the liquid manure from their farms to sometimes distant meadows. (PS)

From timeline/statistics:

1970 - 1992 population increased from 1’876 to 2’195 (BERNHIST)

1970-1990: The residential population of the Lenk increases. On one hand, the flourishing tourism industry leads to immigration, on the other hand birth-rate exceeds death-rate. The residential population of the Lenk is getting older as young people emigrate and elderly people immigrate. Several external owners from second homes come to live yearlong in the village Lenk. (Bannwart 1999)

1968: In 1968 the community of Lenk decides to realise a local planning. Very large, undifferentiated building zones are planned. Due to the new cantonal building law of 1970, the community of Lenk has to revise its building zones. Still many scattered holiday home zones remain. They are only insignificantly reduced through the revision of the local planning in 1994. In order to get credits for the construction of public buildings and sport facilities, a macroeconomic regional development concept is laid out from 1975 to 1977. (Bannwart 1999)

1970:- In 1970 four new hotels are built in the village Lenk. The number of hotel beds increases until 1985 and decreases thereafter. This is due to the closing of hotels and the enlargement of existing hotel rooms.

Since 1975 the number of group accommodations increases. In 1984 the “Kurs- und Sportzentrum” (course and sport centre) is constructed in the Lenk. (Lenker Bergbahnen 2014)

1977: The motorway is extended from Bern/Thun to Spiez. A slip road at Wimmis leading to the Simmental is built. (Bannwart 1999)
Interpretation driving forces:

The trends launched after World War II continued and partly became even more pronounced during this period: Agricultural abandonment of marginal pasture land, construction of second homes, and an increase in transport infrastructure for agriculture and for tourism.

The melting of the glaciers during this period can be seen as a consequence of the end of the little ice age (after 1850), as reported in the period above, but this time combined with effects of global warming.

Interpretation actors:

Actors directly influenced abandonment, afforestation and increase of built areas, but not processes as related to glacier melt; hereby farmers still are the most important actor group. However, we see increasing influence of actors that are no farmers (any more) and actors that do not originate from the municipality (retired people, actors from the tourism sector like external investors); newly upcoming are also NGOs (e.g. association working against motorway construction and thus preventing increase in infrastructure area).

Again continuing is also the bifurcated trend of farmers working likewise towards intensification and extensification; the relative influence of deliberate action as compared to passive retirement may be seen as increasing.

1992 - 2013

Development, changes, processes

In the last period, the melting of the glaciers was becoming even more pronounced (5.59ha/y), whereas the other changes generally slowed down.

- What is causing the glaciers to melt? And what is again causing persistence?

Driving forces and actors

From OHI:

- The forest did not expand a lot here (EZ)
- Farms and farm areas are bigger than before. This is because of the mechanization of agriculture. And also because of the ensilage of forage (HZ)
- There are a little but less hedgerows and single trees in the landscape than 10 or 20 years ago (EZ)
- Glaciers as the Wildstrubel glaciers today are only grey belts in warm summers (EZ)
- Farming was less intensive on the valley floor. Today the grass is cut four times a year. Then it was only twice a year (HA)
- It is clear that the climatic timberline moved upwards. But you know that yourself. I think it moved at least 100 meters upwards (HA)
- The biggest changes happened here [near the village center] and it consists of the buildings. This is all man-made (HA)
- You don’t see the glaciers from down here. The glaciers are melting fast (HA)
- Yes, there is the Alpverein Simmental and Strukturverbesserungsgenossenschaft, a farmer organization. They had a quarrel because of contrasting interest. Farmers have a great influence. But they are not free to do what they want. Officially they are self-employed workers but trough the subsidises they have to fulfil what is expected from the authorities.
Farmers got their pride back with initiatives like ‘AlpKultur Simmental’ which tries to preserve and revive traditions and promotes high-quality products. This leads also to a better awareness that an intact landscape is important. (PS)

**From timeline/statistics:**
- 1992 – 2014 population increased from 2’195 to 2’416
- 1993: To secure income of farmers, regulate production and protect the environment, direct support schemes are established. Farmers receive a certain amount of money depending on the farming conditions and the rendered additional services for the environment (such as the maintenance of Buntbrachen) (Schmid et al. 2012)
- 1864: Temperature increased from 1864 until 2012 about 1.8 °C. The zero degree level advanced since the 1960s about 300 meters. The climate warming leads amongst others to melting glaciers and advancing snow lines. (BAFU 2013 / BAFU 2014)
- 2012: Construction of secondary homes is limited by law. The popular initiative to set limits to the construction of secondary homes is adopted. It bans the construction of second homes in communities with a share of second homes higher than 20 percent. The share of second homes in the community of Lenk is estimated at around 70 percent. (ARE 2014)

**Interpretation driving forces:**
Apart from melting glaciers, the rates of change declined. Zoning regulations, a rather slow economy and ongoing subsidies for agriculture prevented major changes.

**Interpretation actors:**
For this period, there is a stabilization of actors and their behavior due to more stable socio-economic environment (no new driving forces, slowing down of effects of existing ones, incentives for preventing negative effects), all of this resulting in greater persistency.
3.3 Spain – Sierra de Guadarrama foothills – Colmenar Viejo

Land use/Land cover changes

Figure 3.3.1 Land use/Land cover changes in Colmenar Viejo on legend level 1

Figure 3.3.2 Land use/Land cover changes in Colmenar Viejo on legend level 2
Figure 3.3.3 Mapped land use/Land cover changes in Colmenar Viejo on legend level 2
1875 - 1946

Development, changes, processes

Between 1875 and 1946, agricultural land was converted at a high rate of 110.4 ha/y into grassland – a change which was mostly caused by the conversion of seasonal agricultural land into meadows and pastures (90.9 ha/y). Seasonal agricultural land was at the same time at a much lower rate (4.5 ha/y) newly created on wooded grassland and shrubs. In sum, the seasonal agricultural land dropped sharply from 45.92% to 7.97% of the total area. Within the grassland category, wooded grassland and shrub was also converted into meadows and pastures at a high rate of 72.8 ha/y. Consequently, this new category increased from 0% to 65.95%.

At a lower rate, forest was converted into grassland (3.2 ha/y into meadows and pastures - 1.4 ha/y into wooded grassland and shrub) and seasonal agricultural land (2.8 ha/y), reducing the forest cover from 4.20% to 1.30%.

The related processes are foremost an extensification of agriculture (110.4 ha/y), followed by deforestation (7.5 ha/y), expansion of agriculture (7.5 ha/y) and the intensification of agriculture (4.5 ha/y).

-> What led to this massive increase in pastureland at the expense of seasonal agricultural and wooded grassland and shrub?

Driving forces and actors

From OHI:
- Up to the 1950s, ovine livestock was very important (demand for wool) (SMG)
- Small vineyards were widespread (SMG)
- Before the war, there were many wild stock farms (JA)
- In the past, wild stock farmers also owned arable lands to produce the fodder for the animals. (MS)
- Arable lands have disappeared. They were only for subsistence production. (MS) – reference time unclear.
- Before quarrying started, 99 % of population were farmers (SMG)
- The people of Colmenar Viejo have been big enemies of the trees because they were not useful for grazing (EF)

From timeline/statistics:
- 1865: Very high numbers for sheep (77’216), goats (12’850), and pigs (11’133). Lower numbers of bovine (10’823).
- 1891: Peak of wild stock breeding (Ruiz 1989)
- Beg. 20th century: Many industrial quarries appeared in the municipality to extract porphyry and granite. (Jorda et al. 2009)
- 1911: Train to Madrid constructed (for stones) (Ruiz 1989)

Interpretation driving forces:

During this time, a first period of conversion of subsistence farming to market-oriented farming took place. Cropland was converted into grassland. Apart from goat and sheep, breeding wild bulls became more important. They need pastures, but also more nutritious crops, triggering in places an increase in cropland (i.e. a reverse trend to the one mentioned above). People improved grazing ground by actively removing shrubs/trees.
Many industrial quarries started. The quarry led to the construction of a railway to Madrid. But also milk was easier to be transported quickly to Madrid, where dairy plants were founded, making dairy farming more attractive.

Source critical remark: Meadows and pastures as LU category was new in the 1946 map. We do not really know, if it could not also have been mapped in 1875.

Interpretation actors:

Farmers, in this period still constituting the greatest share of the population, are prime actors. They cause change mainly by switching to other practices, like for instance wild stock breeding. Likewise directly triggering change processes are quarry developers, usually actors external to the area to whom local landowners rented part of their lands.

1946 to 1971

Development, changes, processes

Between 1946 and 1971, the newly dominating category meadows and pastures were became overgrown into wooded grasslands and shrubs at a rate of 82.6ha/y, and wooded grasslands and shrubs became forests (1.8ha/y). Urban areas expanded on meadows and pastures (8.0 ha/y) and to a lesser degree on seasonal agricultural land (0.2ha/y), leading to an expansion of urban areas from 0.37% to 1.49%.

Thus, abandonment took place at a rate of 10.5ha/y, and urbanisation was the second most important process (8.6ha/y), followed by afforestation (1.9ha/y).

- Why were meadows and pastures overgrown? What triggered the start of urbanization?

Driving forces and actors

From OHI:

- Wild stock farms decreased a lot after the Spanish Civil War (SMG) incl. misery and food crises (PC)
- Wild stock: During the war and post-war times people had to kill the animals to feed themselves and to feed the population in Madrid. (JA) also (MN)
- During the war many things happened that damaged the breeding of wild stocks (FM)
- During the post-wart time bullfighting changed a lot. Bulls from SM were too fierce (FM) also (MN) similar (MS)
- Agriculture (i.e. cropland) in the municipality disappeared in the 1960s (SMG)
- In the late 1950s, people abandoned the animals for the stones (quarries) (SMG)
- With Franco, the Dehesa de Navalvillar (common land used for grazing with precious pastures) was occupied to be used as a military shooting field. This was a problem for the farmers that did not own private lands and needed the pastures of the Dehesa to feed their animals (PC)

From timeline/statistics:

- 1936-39: Spanish Civil War was a blow to wild stock breeding (Ayuntamien to de CV)
- 1941: Military practice ground established in the northwest of the village
- 1960-1970: population increased from 8’483 to 12’826 (statistics)

Interpretation driving forces:

Overgrown meadows and pastures might be early signs of abandonment of wild stock breeding (since end of Spanish Civil War) and farming with ovines (from 1960s onwards), as less effort seems to have gone into maintaining the grazing grounds. Alternative jobs were available in the quarries—the growing capital Madrid was expanding rapidly. Population increased, most likely more people were working in the quarries and the construction sector.
Interpretation actors:
Farmers have a continued, but lower degree influence on land change processes. The ways of being involved in land use changed over individual people’s lifetime, typically starting with farm labour at young ages and later turning to quarrying and construction. Farmers are partly inhibited from former uses (e.g. military training ground instead of common pastureland). Social diversification results in an increased relevance of people without a farming background, resulting in fewer people directly influencing land. The general population increase leads to an increase in built areas. Besides people moving or commuting to the area, also the military is showing up as a new actors group with very particular interest in the land.

1971 to 1988
Development, changes, processes
Between 1971 and 1988, meadows and pastures continued to be converted into wooded grassland and shrubs (96.2ha/y), but also into seasonal agriculture (56.4ha/y). The reverse trend, i.e. the conversion of agriculture to grassland took place too (42.1ha/y), mainly due to the conversion of seasonal ag to meadows and pastures (35.1ha/y), to urban (7.3ha/y) and to wooded grassland and shrubs (7.0ha/y). Urban areas expanded rapidly to 4.54%, mostly on meadows and pastures (19.7ha/y) and also on wooded grassland and shrubs (5.9ha/y). Forests grew on meadows and pastures (3.2ha/y) and quarries became established on seasonal agricultural land (2.7ha/y).
Overall, intensification of agriculture took place at a rate of 58ha/y, whereas the reverse, i.e. extensification happened at 42.2ha/y. The rate for abandonment was 37.6ha/y, urbanisation increased to 32.9ha/y and forests expanded at 4.7ha/y.
-> trend from previous period continued and accentuated

Driving forces and actors
From OHI:
- After the 1960s ovine livestock decreased a lot (lower demand for wool), focus on bovine livestock (SMG).
- Rural exodus: in the 1960s, nobody wanted to keep ovine livestock, farmers abandoned their land and started working in the construction sector or in companies. But there is also an increase in dairy farming, smaller/larger farms (SMG)
- Still in the 1960s there were some quarries that today are covered with apartments and hotels (EF)
- In the 1960s the work of the stone was abandoned due to the introduction of machinery, and people searched for jobs in companies linked to the construction sector, which was in expansion (SMG)
- People that worked in the quarries stopped their activity when the machinery for cutting the stones was introduced (FD)
- Since the cultivation of land disappeared, the landscape has changed a lot. Now there are more trees (MS)
- Smallholders having cows and hens around their house were widespread in the 1970s (JA)
- With the democracy (1975? 1977?), direct selling was prohibited, cows were banned from the city (JA)\(^1\)

\(^1\)Comment Maria: I have found a regulation from 1961 that banned the cattle from the villages that have a population bigger than 10,000 inhabitants! What might have happened is that when the law was passed, Colmenar Viejo still had less than 10,000 inhabitants and the law might have been applied in the 70s with the population growth. The law also says that this has to be achieved within the following 10 years. The first interviewed might have perceived this as a consequence of the Democracy. This would also explain why the next interviewed say that caws were banned when second home residences were built. (Decreto 2414/1961, de 30 de noviembre, por el que se aprueba el Reglamento de actividades molestas, insalubres, nocivas y peligrosas. (Vigente hasta el 17 de noviembre de 2007) http://noticias.juridicas.com/base_datos/Derogadas/r1-d2414-1961.t1.html#a13
This might be due to higher sanity controls. I have done a bit of research and found out that the first regulation regarding food quality control in Spain was written in 1967 (Decreto 2484/1967, de 21 de septiembre, por el que se aprueba el texto del
Deliverable D3.3

− When people from Madrid started to build their second home residences in the village, the cows had to move to the countryside (PC)
− The new highway triggered an increase in numbers of commuters to Madrid (PC)

From timeline/statistics:
− 1970-1991: population almost doubled from 12’826 to 23’780 (statistics)
− 1980s: Phenomenon of the second residences start increasing in Colmenar Viejo (Brandis 2012)

Interpretation driving forces:
SM became much more accessible for people from Madrid because of the construction of the highway, triggering a massive increase in urbanization/settlement increase. Subsistence farming largely given up and settlement change their character with more second home residences. Quarrying became more mechanized and people started to take jobs in the tertiary sector (leather factory / IBERIA).

Interpretation actors:
The increasingly diversified land change patterns mirror the increasingly diverse range of actors and related interests. Farmers (farming activities) lost influence as many of them turned to other professions; the remaining ones applied other practices (dairy farming) within a tight regulation frame, limiting individual action. New actors, most notably commuters, quarry exploiters, and the construction sector gained influence. The general land use paradigm shifted from cultivation to exploitation.

1988 to 2000

Development, changes, processes
Between 1988 and 2000, seasonal agriculture was converted back to meadows and pastures at an even higher rate as it had been established in the previous period (78.1ha/y), reducing its area to 4.17%. Also meadows and pastures were again converted into seasonal agriculture at a high rate (20.1ha/y), whereas the conversion to urban slowed down to 8.1ha/y on meadows and pasture and 4.0ha/y on seasonal agricultural land. Quarries expanded mostly on meadows and pastures (1.8ha/y).
This results in an extensification of agriculture with a rate of 83.1ha/y and an intensification at 24.0ha/y. Abandonment took place on 17.3ha/y and urbanization on 15.1ha/y. The expansion of bare soils were due to the expansion of quarries at a rate of 2.5ha/y.

→ trend broken: meadows and pastures no longer overgrown, but seasonal agriculture largely given up.

Driving forces and actors
From OHI:
− … This changed in the 1980s due to CAP (EF)
− CAP and the milk quotas destroyed the dairy farming system. People had to substitute their dairy cattle for cattle for meat production (SMG)

Código Alimentario Español) and passed in 1974 (Decreto 2519/1974, de 9 de agosto, de entrada en vigor, aplicación y desarrollo del Código Alimentario Español / Real Decreto 2561/1982, de 24 de septiembre, por el que se aprueba la Reglamentación Técnico-Sanitaria de Industrias, Almacenamiento, Transporte y Comercialización de Leche y Productos Lácteos). This might be the reason why the milk could not be sold directly to the neighbours anymore.
From timeline/statistics:
- 1986: Spain joins the ECC. The CAP of the 1980s had a strong impact in the livestock farming of the region, due to the quotas to milk products. The number of cattle holdings and the number of livestock heads decreased, and at the same time, the size of the holdings increased. The milk cattle lost importance and the meat cattle gained it.
- 1991: Formation of Tres Cantos as a separate community. SM becomes a commuter town.
- 1991-2000: population increase from 23'780 to 32'459 (statistics)
- 1999: Numbers of sheep (602), goats (134), and pigs (118) much lower than 1865. Numbers of bovine (7'722) now dominating, only reduced by about 20%.

Interpretation driving forces:
The fact that the LULC trend starting after the war was broken might well be linked to CAP and the resulting changes in the agricultural sector. Dairy farming, and seasonal agriculture no longer viable. Commuting increases (comment SLC: Probably it is due to the real estate boom that started in the late 90s. The European Union agreements for the introduction of the Euro in 1999, resulted in a decrease of interest rates. This, together with a higher demand of housing due to the emancipation of the baby boom generation of the 70s, led to an increase of the activities in the real state sector).

Interpretation actors:
Farmers’ still ongoing strong influence on land is revealed by the considerable changes caused by CAP. In this period, farmers are again reorienting towards other practices, acting at a divide between intensification and extensification. As for other actors and related processes, trends continued (increase in building activities, quarry exploitation).

2000 to 2012
Development, changes, processes
Between 2000 and 2012, urban areas expanded from 5.48% to 7.59% on meadows and pastures (26.4ha/y) and on wooded grassland and shrubs (5.9ha/y). Meadows and pastures also were converted into wooded grasslands and shrubs (21.7ha/y), whereas this type of grassland also lost due to the establishment of quarries (3.4ha/y) and of forests (1.8ha/y). Abandonment was again high with 34.3ha/y, closely linked with the related process of urbanisation (32.3ha/y). The expansion of quarries to 0.82% of the total area again triggered an expansion of bare soils (4.5ha/y).

- > why again a boost in urbanization? Slight forest expansion

Driving forces and actors
From OHI:
- The economic crises has damaged a lot the construction companies in SM (MN)
- Now there are only two wild stock farms (JA)

From timeline/statistics:
- 1994: Efforts to recover the forest cover of the Dehesa de Navalvillar
- 1995: Law passed by the Autonomous Community of Madrid to protect the forests
- 2000s: Commuter train system to linking Colmenar Viejo and Madrid, as the road system is reaching its capacity.
- 2000-2011: population increase from 32’459 to 45’468 (statistics)
Interpretation driving forces:
Further increase in commuting. Quarrying seems to be expanding (based on LULC), but little information is given on the present situation of quarrying, e.g., if some of the areas are also used as dumps for waste disposal, or quarrying actually takes place.

Interpretation actors:
The trends revealed in the previous periods continued, but at a slower pace. Also for actor constellations and relevance we see a stabilization of processes.
3.4 Sweden – Uppland – Börje

Land use/Land cover changes

Figure 3.4.1 Land use/Land cover changes in Börje on legend level 2
Figure 3.4.2 Mapped land use/Land cover changes in Börje on legend level 2
1861 to 1945

**Development, changes, processes**

From 1861 to 1945, seasonal agriculture increased from 30.57% to 40.20%, at a rate of 4.95ha/y on grassland and shrub, and on 1.78ha/y on forest. Grassland and shrub declined from 13.44% to 4.34% - not only to seasonal agriculture, but also at a rate of 1.58ha/y to forest, with the reverse trend (i.e. from forest to grassland and shrub) was lower (0.85ha/y). Urban areas expanded from 2.41% to 3.64%, primarily on forest (0.60ha/y).

The main process was therefore an intensification of agriculture (4.93ha/y), followed by deforestation (3.22ha/y), expansion of agriculture (2.85ha/y), abandonment (2.56ha/y) and afforestation (2.30ha/y).

**Driving forces and actors**

*From OHI:*

- 1850ff: “A lot of stone production in Börje before, probably around 10 quarries. If you weren’t a farmer you were a stonecutter. A lot of the stones at the streets in Uppsala comes from Börje parish.” (S)
  (comment SLC: The stone production started around 1850, when the crops failed etc, a way to make some money. Stopped around 1900-1920, definitely after the war in the 40’s when the larger industries took over.)
- 1915/-20: Electricity introduced (PLA)
- 1921: Milking machines – introduction was fostered by the lack of female work power, as many women moved to the nearby city of Uppsala for work.
- 1934: Wetland along river was drained – improve of arable land (PLA)

*From timeline/statistics:*

- 1860-1940/1950: population decrease from 800 to 735/647 (statistics)
- 1861-1930: Emigration from Sweden due to famine (Myrdal 2001). “In 1867, 1868 and 1869 followed a series of catastrophic famines during the 1860s, caused first by too much rain, then drought and finally epidemics led to crop failures and even more misery among the poor farming population. Some sixty thousand Swedes left the country during these three years of starvation alone. This was the beginning of a mass emigration wave mainly to the United States from 1868 to 1914. After World War I the emigration picked up again but came to a halt again during the depression in the 1920s.” ([http://www.european-emigration.com/se/reasons.html](http://www.european-emigration.com/se/reasons.html))
- Industrialization draws people from rural areas to urban centres (Myrdal 2001).
- 1904: Railway station – quick link to Uppsala

**Interpretation driving forces:**

During this period, people emigrated due to bad harvests and left also to work in industry instead of the first sector. The remaining agriculture was more intensive, including more crop production. The maps reveal that the increase of seasonal agriculture on grasslands happened mostly along the rivers in the center of the SM and along its north-eastern border. This might well be the result of drainage projects, such as the one mentioned in the OHI with PLA.

The railway connection to Uppsala most likely facilitates commuting as well as transporting agricultural goods to the city market.
Interpretation actors:

Farmers working towards more productive systems are at the center of the changes in this period. Besides that, as shown in the OHI, also stonecutters are directly influencing the landscape, although this is not visible in the maps. With commuters a new actor type is developing, most likely with a passive relationship towards change processes, because these people were not (or less) dependent on agriculture anymore and so could either abandon, extensify, or leave their land to the remaining farmers.

1945 to 1977

Development, changes, processes

The intermediate period shows generally little changes. Seasonal agriculture declined slightly to 39.20%, mostly due to the conversion to grassland and shrub (1.63ha/y), to forest (0.66ha/y) and to urban (0.54ha/y). Grassland and shrub was however also converted to seasonal agriculture (1.08ha/y). Urban areas expanded to 4.76%, mostly on forest (0.90ha/y) and the mentioned conversion of grassland and shrub.

Thus, abandonment was the main process (2.37ha/y), followed by urbanization (1.86ha/y), extensification of agriculture (1.63ha/y), afforestation (1.49ha/y) and deforestation (1.27ha/y).

Driving forces and actors

From OHI:
- WW II: Led to high grain prices (PLA)
- 1968: Train stopped running, people buy cars (PLA)
- 1950s: Farms are converted into forests (S) (“The fields are turning into forests, damn that Uppsala Academy who turned 380 farms into 30, turning fields into forests just to make money.” “Farm lands to forests, in the 50’s. All over the place.”)

From timeline/statistics:
- 1940/1950-1960: population decrease from 735/647 to 590 (statistics)
- 1950s: Increase in use of agrochemicals (Flygare & Isacson 2003)
- Measures were taken to make the area move attractive for young people (1969: sports club) (MBA).
- 1967: Government policy for rationalization of agriculture (Lindberg 2008)

Interpretation driving forces:

The further increase in urban areas stands in contradiction with the continuous decline in population. It is likely that commuting by car to Uppsala became more common, with people living in new and larger houses, compared to the traditional farming community. Afforestation was actively pursued and the intensity of agricultural production on the still remaining cropland most likely increased to the 1967 policy.
Interpretation actors:

There are no changes regarding actors driving the change processes in this period. Farmers’ activities towards intensification seem to have considerably slowed down, though, whereas the continued trend towards leaving agriculture and commuting to the city most likely accounts for the urban development activities and the moderate extensification and afforestation processes.

1977 to 2013

Development, changes, processes

The decline in seasonal agriculture accelerated, going down to 33.08%. This was mainly due to the conversion into grassland and shrub (7.40ha/y), less so to urban (0.49ha/y) and forest (0.39ha/y). Forests stayed almost stable at 51.42%, as forest expansion on seasonal agriculture was compensated by a conversion of forest into grassland and shrubs (0.65ha/y) and into urban (0.52ha/y).

The dominant process therefore was an extensification of agriculture (7.40ha/y), whereas the rate for abandonment (1.36ha/y) and urbanization (1.28ha/y) declined slightly. Deforestation stayed almost stable at 1.25ha/y.

Driving forces and actors

From OHI:
- Since around 2005, the summer pastures are not used much anymore (MBA).
- Agriculture today is more export-oriented, less shifts in rotation, more fertilizer use (MBA).
- Larger, fewer farms. Farms closed since the 1990s (IJ)
- Shift from dairy cows/pigs to horses/beef cattle (IJ). See also (BA)
- There was little profit in keeping animals any more (BA).
- Shift from animal husbandry to grain production (PLA) (same (S)).
- Wheat dominates today, also rape and flax (PLA)
- Since 1980s: More monocultures, less grassland, less cows, more horses (I) “You can grow more, if you don’t have animals to take care of” (I).
- More agrochemicals to sustain the larger production (I).
- Today imported feedstuff instead of turnips and potatoes (IJ).
- Larger investments in agricultural technology, which hardly pay off (IJ).
- Result of agricultural politics on the level of Sweden and EU (IJ).
- Many new houses were built (IJ) (same (I)).

From timeline/statistics:
- 1960 to 2000: population increase from 590 to 928 (statistics)

Interpretation driving forces:

The increase in average farm size, and the abandonment of dairy farming, paralleled by a concentration on wheat production on cropland and of horses (probably mostly leisure purposes) stands for profound remodeling of the agricultural sector, shaped by the respective national and EU-legislation. The further expansion of urban areas is well explained by the proximity to Uppsala and the increase in commuting by car.
Interpretation actors:

Farmers are still central to land change processes in the area. In this period, they are again adapting to changing market and policy conditions, e.g. by reducing grasslands. However, this has to be seen as a continuation on the way of increasing possible returns from agriculture, and not so much as a trend towards a gradual abandonment of agriculture. New actors, i.e. a non-farming population, now adding leisure activities to previous urban development activities, are gaining influence.
3.5 Estonia – Vooremaa & Kodavere – Alatskivi & Peipsiääre

Figure 3.5.1 Land use/Land cover changes in Alatskivi & Peipsiääre on legend level 1

Figure 3.5.2 Land use/Land cover changes in Alatskivi & Peipsiääre on legend level 2
Figure 3.6.3a Mapped land use/Land cover changes 1891 – 1989 in Alatskivi & Peipsiääre on legend level 2
1891 - 1937

**Development, changes, processes**

During this time, wetlands were reduced from 14.74% to 5.88% of the total area. They were converted into meadows and pastures (15.65ha/y) and into wooded grasslands and shrubs (14.89ha/y). The expansion of urban areas on seasonal agriculture (5.14ha/y) and of dry forests to meadows and pastures (4.51ha/y) were less widespread.

Consequently, the expansion of agriculture (41.86ha/y), mostly due to drainage (33.80ha/y) were the dominant processes.

**Driving forces and actors**

*From OHI:*

- During “Estonian time” (SLC: i.e. previous independence period) all was cultivated, land was appreciated (EV)

*From timeline/statistics:*

- 1918-20: Estonian war of independence. Was a defensive campaign of the Estonian Army and its allies, most notably the White Russian Northwestern Army, Latvia, and the United Kingdom, against the Soviet Western Front offensive and the aggression of the Baltische Landeswehr. It was fought in connection with the Russian Civil War during 1918–1920. The campaign was the struggle of Estonia for its sovereignty in the aftermath of World War I. It resulted in a victory for the newly established state and was concluded in the Treaty of Tartu. (Wikipedia 23.11.2015)

- 1919: Land reform in Estonia: Land owned by estates (1065 estates owning over 1.9 mio ha of land) was nationalised and about 56,000 new small farms were erected on this land.
Deliverable D3.3

− 1919: Nationalising Kokora estate. The estate had been erected on the former lands of Alatskivi estate in 1734 and this estate also was nationalised during the land reform. This caused the abandonment and later ruination of the buildings of the estate.
− Additional information can be found at http://www.starover.ee

Interpretation driving forces:
During this period, the estates have been converted into smaller farming units, which later were organized into large collective farm units, i.e. the Kolkhozes. Most of the drainage projects might have been conducted as part of the expansion and intensification projects of these Kolkhozes.

Interpretation actors:
The change processes in this period are clearly driven by changes in the actors that were farming the land. The first shift from large-scale private landowners to small-scale farmers as well as the second from small-scale farmers to collectively-run Kolkhozes resulted in the expansion and intensification of agriculture.

1937 - 1963
Development, changes, processes
The dominant development was a massive increase in area covered by dry forests from 25.03% to 43.20%. Meadows and pastures were on one hand overgrown by dry forest (20.69ha/y) and on the other hand converted to seasonal agriculture (16.93ha/y). As third most important change, wet forests were converted into dry forests (10.99ha/y) and dry forests also expanded on seasonal agriculture (8.20ha/y). Afforestation (63.97ha/y) on one hand and abandonment (60.30ha/y) on the other hand were by far the most important processes. But also intensification of agriculture (20.94ha/y) and further drainage (11.06ha/y) contributed to the dynamics of this period.

Driving forces and actors
From OHI:
− It (the farm) was all treeless, hay meadows when I came here (in 1958) (EV)
− Kolkhozes took everything. People without land were then happy. Those who had to give up their lands, they suffered. … Kolkhoz made natural hay at first, then the further and less valued lands were abandoned as more valuable field-hay appeared: clover, lucerne, kaleega – kitsehernes – Galega. … Kolkhozes used machinery that was taken from farms (EV)
− Meadows were sparse here. Kolkhoz land was, there was cattle, sovkhoz also had a cattle. Everywhere was mowed. (AP)
− The salaries were virtually non-existent at early kolkhoz times. Later we had two cows as children grew and this subsistence farming supported the small salary the state paid.(EV)

From timeline/statistics:
− 1940-41: Soviet occupation.
− 1941-44: German occupation.
− 1944-91: Soviet occupation.
**Interpretation driving forces:**

The Kolkhoze-regime was continued, but concentration tendencies are visible, i.e. further drainage and conversion of pasture to cropland on one hand, but also abandonment and afforestation on the other hand.

**Interpretation actors:**

The influence of small-scale farmers that would cultivate almost all available land came more or less to an end. The organization of agriculture in large-scale land units supported the twofold development evident in this period: The intensification of better lands on the one hand and the abandonment/conversion into forests of less profitable areas on the other hand.

**1963 - 1989**

**Development, changes, processes**

Apart from the disappearance of the wetlands (from 4.39% to 0.71%), we see little net change of land cover (Fig 3.6.3a) during this period. These wetlands were converted into wooded grasslands and shrubs (13.80ha/y) and to dry forests (7.89ha/y).

Drainage (25.34ha/y), expansion of agriculture (22.35ha/y) and afforestation (15.04ha/y) were the processes reflecting these changes.

**Driving forces and actors**

*From OHI:*

- Before, it was common herd. Shepherd collected them and took them behind the village. But now where? (AP)
- We know there is a lake but it is not visible. No bushes before as all went for firewood. We didn’t have own forest, had to buy firewood, usually from Estonians so that we sawed a plot ourselves and took them out. (ZK – maybe also in period before)
- Electricity came late, 1963 I think, kerosene lamps before. (AP)
- Since 1965 gardening land 300 ha: 100 ha for carrots, 100 ha for cabbage, flower seeds, seed growing (cabbage, rutabaga/swede, turnip). We were subordinates to gardening ministry and through that to Moscow. No destruction on purpose. (MK).
- 1987 we quit gardening, sovkhoz was liquidised 1993. We had two tractors but nobody works with them. (MK)
- Where Alatskivi township ends, now there is a park planted at sovkhoz time as it was always wet, in the beginning of sovkhoz there were cattle but then they moved new barns behind Kasvumetsa [? – AP], fields, nothing happed and then these drainage systems were discovered. I was doing my practice here in 1959 and chief-agronom of that time was with Estonian education, then s/he showed me. Kindergarten was built on some old drainage, 1986 and their basement is unusable because of water. The systems have been ruined. (MK).
- 1969 amelioration was done (MK).
- Amelioration has completely ruined the village landscape…. The purpose wasn’t perhaps always to have new fields but just amelioration and it was better to do it on sandy areas – easier, but where there were stones and swamps it was difficult and so they turned our hay meadows into swamps and pastures into stone piles. … Amelioration ruined ground water. (ET)
From timeline/statistics:

- 1960ff: Melioration. This resulted in gaining more agricultural land, but on the other hand it caused great changes in the natural landscape. For example, the Alatskivi River was led into another bed (before 1973), which caused drying of the original river bed and the change of landscape and land cover due to the change of the water regime.
- 1964: Establishment of Alatskivi Land Preservation Area, causing many restrictions to land owners [there were no owners during Soviet period, i.e. users], but has helped to preserve the biodiversity and historic landscape.
- 1968-1973: Road building (Tartu-Kallaste)

Interpretation driving forces:

Drainage was continued, and parallel to the Kolkhozes, people worked their gardens where foremost onions were produced and partly sold. Local resources were also used for heating, i.e. the use of firewood kept the expansion of bushes under control.

Interpretation actors:

With centrally planned melioration measures being at the core of change processes in this period, a single actor (group) continued its major influence on land use. In several regards this conflicted with needs of the local population, which, due to the establishment of a protected area, faced even fewer possibilities to use the land independently and for their own purposes.

1989 - 2014

Development, changes, processes

During this last period, dry forests again expanded (from 44.16% to 52.01%), reaching the highest value recorded, whereas seasonal agriculture dropped from 28.17% to 21.56%. Obviously, these developments are linked: Seasonal agriculture was converted to dry forests at a rate of 23.14ha/y. Seasonal agriculture was also converted into meadows and pastures (17.71ha/y) and wooded grassland and shrub became dry forest (23.18ha/y).

Afforestation (57.64ha/y) and abandonment (56.50ha/y) were therefore the dominant processes, followed by extensification of agriculture (26.04ha/y).

Driving forces and actors

From OHI:

- When you don’t mow the land in two years, it is overgrown (EV)
- Lake is no longer visible, because it is all overgrown (EV)
- Firstly, we didn’t have so much reed, the coast was clear. My Mom remembers when it was absolutely clear (AP).
- Interestingly, lakes dry up. Yesterday I met a lady who originates by Peipsi and lives now here in Naelavere. In Nina village lighthouse is 3–4 m away from water, Lahe lake overgrows, Kolkja and Varnja the Peipsi can’t be seen because of the reed, lake retreats.(MK)
- But the lake has moved towards the village several meters and many trees have fallen in. On the other hand the level of water has in recent couple of years been very low. The shoreline is changing constantly. (ET)
- Fields nearby house remained, the further away, overgrown less valuable. (EV)
We sold our last cow in 1999. Why agriculture waned? Russian market was lost by 1991, fuel is expensive. With spade it is ok but can’t do it for profit, just for yourself, but fuel is expensive. … No profit. If it would be profitable, somebody would do it. (EV)

Most important thing is the overgrowing. With the new Estonian time I thought it is like mediaeval times – forest and brushwood everywhere and some roads. (EV) / (AP) / (MK) / (ET)

The farther hay meadows, where there were flax/linen soaking holes it is bush land on swamp now despite of all the amelioration ditches, the land is soft. (ET)

The land is very low and we have got used to it, we have very tender relation to land because our ancestors, our garden beds, we are fanatics, possibly. The last ones, like mammoths as our children don’t like to work like that. They know that they can earn money more easily. … My husband worked in kolkhoz. But now here is nowhere to work. And youth leaves. All of them. (AP)

At us people don’t love if it’s overgrown. We pity the land. Pity to abandon. Do you get it how much pain it causes us to downsize and downsize. Soul hurts. (AP)

If you are native you can see the waste of the land into bush land and forest but old people don’t have the strength to clean it. (ET)

In 1990s by 2005 nobody cared, now more cultivation. PRIA [Põllumajanduse Registrite ja Informatsiooni Amet – Estonian Agricultural Registers and Information Board (ARIB) – deals with distributing EU agricultural support in Estonia – AP] support can earn an income. (EZ).

Agriculture is coming back? Not so much, can’t tell, not so much as old days but it seems a bit more than before. (ZK)

Gardening activities have waned, which was popular addition to state job; animal husbandry has been lost, some sheep, 2 families; chicken. The rural farming economy is lost. There are also young people living in countryside (and old) but no cultivation, even for own family, as its physical and today it’s easier and give it up, if you don’t have a machine, for spade its a big patch, for tractor small, and so they give it up. (EZ)

Lately, afforestation that is not normal. In Naelavere village, 5.2 ha has been fields, now pure forest. (MK)

Media and foresters say that forests grow more than we need but I don’t see that forest. Former clear cuts are in bush but it’s not forest. (MK)

Land amelioration: Nobody takes care of the ditches anymore. … Afforestation, new swamps. The money is wasted as amelioration needs constant care taking. There were special people in sovkhoz, ameliorators, whose daily job was to keep the sediments and brushwood away. (MK)

From timeline/statistics:

1991: Estonia became independent. Land restitution to previous owners or their heirs.

Interpretation driving forces:

Due to the end of Soviet occupation and land restitution, agricultural activities dropped significantly, forest area expanded (despite some of it might have the character of bushland, and not forest per se), and seasonal agriculture was converted into pastureland – which might well just be an intermediate stage in the conversion of bushland/forest.

The large scale drainage systems might receive the necessary maintenance, resulting e.g. in an expansion of wet forests on former wooded grassland and shrubs.

Agricultural payments by EU might trigger some revival of agricultural activities, which however might only partly be based on local initiative.
Interpretation actors:

Abandonment and extensification of agricultural uses is the dominant land-use trend in this period. It can be traced back to breakdown of the former management system, which was steered by few centrally acting persons/groups. Although with the restituted owners new and diversified actors gained potential influence, this is not visible in terms of a revitalization of farming, most likely due to lacking profitability.
3.6 Great Britain – South West Devon - Modbury

Figure 3.6.1 Land use/Land cover changes in Modbury on legend level 1

Figure 3.6.2 Land use/Land cover changes in Modbury on legend level 2
During the first period, grassland and shrubs were converted into the dominant land cover class crop (0.62ha/y, increasing from 84.69 to 85.68%) and into forests (0.19ha/y), which also expanded on cropland (0.13ha/y). The increase in urban areas happened mostly on cropland, but was rather slow (0.16ha/y).

Agriculture was therefore on one hand intensified (0.62ha/y), and at the same time abandoned (0.60ha/y). Afforestation took place at 0.37ha/y.

Figure 3.6.3 Mapped land use/Land cover changes in Modbury on legend level 2
Driving forces and actors

From OHI:
Yet to be conducted.

From timeline/statistics:
- Population from 1881 to 1951 shows a decrease from 1751 to 1110 (the peak was in 1831 with 2194).
- 1914-1918: Significant reduction in available workforce during WWI.
- 1939-1945: Area used for training and embarkation preceding operation overlord (D Day). Substantial impact on the landscape – including consolidation of agricultural land by tanks.

1947 - 1989

Development, changes, processes

The changes observed in the first periods, were partly continued, such as the conversion of grassland and shrubs into cropland (0.53ha/y) and into forest (0.1ha/y), as well as an expansion of urban land cover on cropland (0.21ha/y). The conversion of cropland into grasslands and shrubs became the most important change (0.68ha/y), preventing a further overall expansion of the proportion covered by cropland, despite cropland also increase on perennial agriculture (0.39ha/y).

Intensification (0.53ha/y) and abandonment (0.45ha/y) were still observed, but expansion of agriculture (0.70ha/y), extensification of agriculture (0.68ha/y) and deforestation (0.59ha/y) were more important.

Driving forces and actors

From OHI:
Yet to be conducted.

From timeline/statistics:
- Population from 1951 to 1991 shows an increase from 1110 to 1342.
- 1960: AONBs are designated under the National Parks and Access to the Countryside Act 1949, amended in the Environment Act 1995. South Devon AONB includes roughly the south-western third of the SM.
- 1980s/90s: Nearby town of Ivybridge underwent a period of rapid growth, perhaps due to the A38 road by-pass (Wikipedia).
1989 - 2012

Development, changes, processes

In the last period, the conversion of grassland and shrubs into cropland increased to 1.15ha/y and cropland also continued to increase on perennial agriculture (0.5ha/y). The expansion of urban land on cropland continued and with a conversion rate of 0.69ha/y became the second most important change.

The related processes were intensification of agriculture (1.15ha/y), urbanisation (1.02ha/y) and the abandonment of agriculture (1.01ha/y).

Driving forces and actors

From OHI:
Yet to be conducted.

From timeline/statistics:
- population figures: figures for 2011 not yet available.
3.7 Comparative analysis

Dominant processes

To determine the dominant processes across all SMs and periods, the numbers of absolute rate of change had to be normalized by the different size of the SMs. The rank sum across all SMs and periods reveals that the process of abandonment to be most important (rank sum 117, Table 4), with a slight tendency to increase towards the 20th century. The second most important process already was much less dominant (rank sum 76) was afforestation, which exceeded the importance of deforestation (rank sum 62). However, whereas deforestation showed similar values throughout the study periods (despite less SMs reporting especially in the 19th century), afforestation reached higher values since the 1950s. Expansion of agriculture (rank sum 70) and intensification of agriculture (rank sum 63) were also important processes, the latter with a strong decreasing trend. For extensification of agriculture (rank sum 53), we see an increase since the 1950s. Urbanization (rank sum 41) shows an increase and a peak in the period 2000-2012.

Table 4: The most important process across all SMs and all periods was abandonment. A steady increase in its importance from 1850 to 2012 is partly caused by an increasing number or SMs included. Cells colored in red represent normalized rates of change of > 5ha/y, cells colored in green normalized rates of change of 1<5ha/y. Cells without colors stand for smaller rates.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lenk</td>
<td>4</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td>Colmenar Viejo</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>Börje</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>21</td>
</tr>
<tr>
<td>Plomari &amp; Gera</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Alatskivi &amp; Peipsiääre</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Modbury</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>12</td>
<td>12</td>
<td>17</td>
<td>25</td>
<td>20</td>
<td>24</td>
<td>117</td>
</tr>
</tbody>
</table>

To compensate for the different numbers of SMs reporting at least partially, we determined the average rank sum of the processes per period and per SM reporting (Fig. 3.7.1). This reveals the increasing dominance of abandonment, the decline in deforestation, expansion and most pronounced intensification of agriculture, whereas urbanization and extensification show a general upwards trend.
Figure 3.7.1 To take the different number of SMs reporting per period into account, average ranks per period and per SMs reporting were built for the major processes. No continuous data are available - to make the figure more reader-friendly, the single data points are connected by thin lines.

**Periods of stability and change**

The relative ranking of processes does not contain any information regarding the rates of change. To determine the driving forces and actors being present in periods of high landscape dynamics, periods of highest overall LULC change for all SM were therefore determined on legend level 1 and 2, and again the rates of change had to be normalized by the different size of the SMs. As foreseen, rates were always higher on the more detailed legend level 2. As legend level 2 does not allow to compare the SMs, the analysis had to be restricted to the periods of stability and change on legend level 1.

The fastest changing SMs overall was Colmenar Viejo (38.76ha/y), followed by Plomari & Gera (35.61ha/y) and Alatskivi & Peipsiääre (29.26ha/y). Börje shows about half the changes (16.76ha/y), even less does Lenk (11.43ha/y) and Modbury (5.37ha/y) is the most stable among the SMs included.

The fastest changes per period were recorded for Colmenar Viejo 1971-1988 (77.10ha/y), 1988-2000 (69.45ha/y) and 1875-1946 (66.73ha/y) followed by Alatskivi & Peipsiääre 1937-1963 (60.37ha/y). For Plomari & Gera, only one periods 1960-2012 is assessed (35.61ha/y).
The period of the fastest change in Lenk was 1935-1968 (29.80ha/y), but also for the 19th century, similar rates were recorded (21.88ha/y in 1849-1876).

The least dynamic periods, i.e. the one in which the landscape as represented in LULC was most persistent, was recorded for Lenk 1992-2013 (2.68ha/y) and 1876-1914 (2.77ha/y), Colmenar Viejo 1946-1971 (5.65ha/y), and for Modbury 1886-1947 (5.89ha/y).

Whereas some SMs show highly variable rates of change (esp. Colmenar Viejo), others showed little variation (e.g. Modbury with 5.89ha/y / 10.04ha/y / 9.04 ha/y or Börje 24.96ha/y / 14.09ha/y / 22.10ha/y). Overall, it is interesting to note that the latest periods was in no SM showing the highest rates of change, but included the least dynamic period of one SM (Lenk).

This also becomes visible in the average of the total rates of change recorded on legend level 1 and 2 across all SMs (Figure 3.7.2). Thus, the common notion of an ever increasing rate of change might not hold true. Additional interesting pattern are visible: The most dynamic period (apart from a peak in 1875, due to the overlap of the last dynamic year for the first period in Lenk with the start of the first dynamic period in Colmenar Viejo) would be the period from 1938 to 1944, which is an almost perfect match with World War Two.

The figure also show that the pattern visible on legend level 1, despite the very rough classification applied, does not convert into something completely different if legend level 2 is applied.

Figure 3.7.2 Average of the total normalized rates of change recorded on legend level 1 and 2 across all SMs.
Driving forces and actors facilitating persistence and change in cultural landscapes

In a recent paper on “Regime shifts limit the predictability of land-system change” Müller et al. (2014) state that “Land systems often undergo periods of nonlinear and abrupt change that invalidate predictions calibrated on past trends.” The search for driving forces and actors facilitating persistence and change in cultural landscapes might therefore end up with a list of stochastic events which trigger rapid shifts in the trajectories of landscape change. Grasping a century of change at only a few points in time, as done in a study based on map analysis, of course severely limits the chances to be able to pinpoint such a stochastic event.

Focussing on driving forces for rapid changes in Colmenar Viejo 1971-1988, reveals that during the period of 1970-1991, the population almost doubled, despite of widespread abandonment of farming, as people took on jobs in the tertiary sector. The construction of a highway in 1970 enabling commuting to Madrid and subsequent the construction of second home residences. The range of different societal groups influencing landscape change expanded, and with new actors also a shift from an orientation towards farming and cultivation of the land lost influence as compared to activities that may be broadly labelled as exploitation (urban development, quarrying).

The former period of rapid change in the same SM from 1875-1946 was characterized by a massive increase in pastureland at the expense of seasonal agriculture and wooded grassland and shrub. This can be interpreted as a gradual change from subsistence farming to market-oriented farming focussing on wild bull breeding and dairy farming. Regarding actors, already here first signs of social diversification are revealed, with new types of actors upcoming and the influence of traditional ones, i.e. the farmers, diminishing. At the same time, farmers switched to new practices and thus also triggered landscape change.

In Alatskivi & Peipsiääre, the period of rapid change was 1937-1963, which was due to a concentration process both in terms of actors (establishment of large land management units) as well as concentration of agricultural activities on the more productive soils where pastures were converted to cropland, and the abandonment of pastureland and expansion of bushes and forests.

The relative peak in land change in Lenk 1935-1968 basically encompasses the period of the so-called 1950s syndrome (Pfister 1996), i.e. the economic boom after World War Two. Agriculture increasingly focussed on the areas where intensification as possible and gave up steeper slopes and less accessible terrain. Like in Colmenar Viejo, also in Lenk new actor groups (investors, people purchasing secondary residences) gained influence in this period with high change rates. Moreover, farmers (as the still most influential actors) triggered changes by modifying their production practices.

Interestingly, both SMs showing periods of very high rates of change, also show period of very low rates. In Colmenar Viejo, the period 1946-1971 was very stable – at least on legend level 1. Pastures and meadows were overgrown (but not converted to forest) due to the decline of wild stock breeding. The massive increase in population (causing some urbanization) was not linked however with changes in the land as they were commuting to Madrid, i.e. a smaller proportion of the local population had an impact on the land.
Even less changes were recorded for two periods in Lenk. From 1876 to 1914, population declined as a result of economic challenges caused by a fire in the village center (1878) and a more widespread economic crises in the 1880s, triggering emigration. Especially shrinking prices for a core cash “crop”, i.e. exported cattle (“Simmentaler”) hit the region hard.

The most recent period in Lenk, again showed similarly low rates of change. Apart from the rapidly melting glacier (which does not show up on legend level 1), a stable, but not growing economy, the stabilizing effect of agricultural subsidies and strict zoning regulations, i.e. a combination of economic with legal and political measures most likely slowed the rates of changes down.

Periods of persistence are more likely not an artefact from the mapping procedure. However, whereas it is very likely that a change in land cover or land use, as depicted on topographical maps, also reflects a landscape change, it is much less certain that a period of little changes on the maps can be interpreted as a period of persistence of the landscape.
4 Discussion

We aimed at developing a procedure allowing for solid comparisons of case studies of LULC and related driving forces/actors across very different landscapes and in very diverse political, historical and biogeographic context. This aim results in specific challenges, such as the need for a common legend largely ignoring the diversity of the different landscapes. It is for example rather confusing for SMs with widespread dairy production based on managed pasture (as e.g. in SM Lenk) that grasslands are not considered to be part of agriculture. For regions with low-intensity pasture systems, or even natural grasslands, this classification however makes sense. Overall, the results reveal pattern which can be interpreted and show differences in rates of change between the different SMs, which underlines the validity of the approach chosen.

Whereas in some SMs, the rates of change were rather stable over time, other SMs show major differences in the rates of change between the different periods distinguished. On one hand, we cannot exclude that a certain share of the dynamics recorded are due to changes in map quality. At the same time, we have to admit that especially in very dynamic landscapes, the attempt to grasp this dynamic with just a few snapshots in the course of a century, has serious limitations.

As this analysis was based on LULC changes, the validity of the findings for landscape changes has to be questioned. Linear elements and point elements were not studied separately, as well as aspects of land use intensity, which are relevant for a wide range of ecosystem services, including ecological as well as aesthetic dimensions (Biro et al. 2013, Bürgi et al 2015), were also left aside. The OHIs provide a wealth of information, which would exactly refer to these aspects of landscape dynamics, which were largely missing here. For example, they reveal that today the grassland is managed much more intensively as in former times, with four cuts a year instead of only two (OHI Lenk, Interview HA). OHIs are also suitable to capture very recent developments, such as recent small-scale revival of agricultural activities in the Estonian SM, which would not be captured by the map series. Thus, our second methodological innovation, i.e. combining well established LULC analyses with oral history interviews also showed to be a fruitful approach.

On a more critical side we have to consider that the number of OHIs per SM is rather small and a bias in results cannot be excluded. From the 42 interviews conducted in the five SM, 24 were with men and 18 with women. Thus, overall the genders are quite evenly represented. However, all six interviews in the SM Lenk have been conducted with men and all six interviews from the Alatskivi & Peipsiääre SM have been conducted with women. One of the interviewees in Alatskivi & Peipsiääre SM state that “For men lake, for women garden” (OHI ZK). The strong focus on onion production and rather limited information on fishing and reed control is therefore very likely a consequence of the selection of interviewees.

Another limitation of the OHIs for analysing landscape change it the daily proximity of the interviewees with their landscape – the consequences are addressed in the following statement: “My older sister comes from Tartu and she doesn’t recognise the home place at all; it is not the same village any more. I who live here everyday life I don’t notice the changes so drastically” (OHI ET). OHIs might very well be the most suitable source to learn about land use practices, and of course for evaluation of local perception of landscapes, interviews are the way to go. But this does not make OHIs necessarily an optimal source for assessing actual changes of the landscape.
Therefore, a differentiated approach is needed and careful interpretation and combination with other sources, such as historical maps as used in this study, or pictorial sources, is advisable.

The analysis of driving forces of landscape change is a challenging task between two very different approaches: (A) a statistical approach studying correlations based on variables which can be quantified, and (B) a descriptive approach searching for the most compelling narrative explaining the changes determined. In HERCULES, additional limitations arose from the aim of conducting a comparative study. The methodology developed, i.e. combining OHI's and local historical studies to interpret changes visible in historical maps which were assessed with a common legend and digitalization procedure, provides highly interesting insights into the dynamics of landscape and land use of the SMs considered in absolute and relative terms. This said, we can of course not exclude that more in-depth studies of the single SMs might result in slightly different versions of the narrative developed. Overall, we believe to have found a way to effectively and efficiently deal with constraints of resources, source availability, and still providing plausible and comparable results across the six SMs included.
5 Conclusion

Our analysis reveals a high diversity of developments, changes, and processes and the related constellations of driving factors and actors across the SMs and over time. This makes it hard to determine common pattern, or shared traits. At the same time, the rather small number of SMs involved, also sets limits to attempts to come to more general conclusions. Still, periods of high rates of change and periods of lower rates of change can be determined and no such things as a general trend towards increasing rates of change was visible in any of the SMs. The fact that the last periods under study we not especially dynamic in any of the SMs is in line with other studies, such as Schneeberger et al. (2007), who found decelerating trends in landscape change along transects from lowlands to alpine areas in Switzerland.

Is it possible to follow Müller et al.’s (2014) call for learning from past regime shifts and identifying early warning signs for future regime shifts? Infrastructural developments, macro-economic shifts and crises or their end in the case of rapid development in the aftermath of World War Two as in the case of SM Lenk, increasing population numbers including the rise of new actors groups without a farming background seem to have the potential to trigger massive landscape changes. Other potential driving factors, such as CAP, did not show up directly, but definitely play a role, e.g. as a driving force of land abandonment (Renwick et al. 2013).

However, the specific context determines if and how such developments have an impact on the landscape. An economic crises triggering emigration, such as in the case of Lenk 1876 to 1914, might well lead to abandonment, which however in the case of pastures in harsh alpine environment might not immediately lead to forest expansion. Abandonment due to the conversion of a community structure from (subsistence) farming into commercial and industrial activities might however trigger rapid changes. Such changes can be largely facilitated by infrastructural developments, enabling easy commuting to nearby centers.

Interviews with local long-term residents might be an optimal way of assessing upcoming changes in actor constellations, i.e. expanding the historical evaluation into an analysis of current and upcoming trends. For the future development of agri-cultural landscapes, it will be highly relevant if the future farming is in the hands of investors buying up land to optimize its return in the current (CAP)-context not caring about local traditions and landscape characteristics at all, or if retired hobby farmers take care of the land, with the aim of maintaining a “traditional” countryside without being dependent on income from products or subsidies – to call two extremes.

The focus of our study was on LULC changes. We did not really look into driving forces of LULC as such. A more in-depth analysis of the basic landscape layout and configuration would have to take into account environmental constraints and availability of various resources, spatial configurations and historical path dependencies.

Our study reflect the diversity and complexity of landscape change processes across Europe. The number of case studies does not allow to draw general conclusions, but enables to develop further hypotheses for research and feedback to the local communities regarding their specific development.
References


www.are.admin.ch/themen/raumplanung/00236/04094/index.html?lang=de


Iosifides T. (in prep.) Perceptions, Meanings and Conceptualizations of Natural and Agricultural Landscape Change in Lesvos, Greece.
Deliverable D3.3


## Appendix A

The composite legend of areal features for all Study Municipalities.

<table>
<thead>
<tr>
<th>Level</th>
<th>Category code and explanation</th>
<th>Category code and explanation</th>
<th>Category code and explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1 – Urban / Built-up</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>2 – Agriculture</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>21 – Seasonal agriculture</td>
<td>211 – Arable land</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>212 – Vegetable gardens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>22 – Perennial agriculture</td>
<td>221 – Orchards</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>222 – Vineyards</td>
<td>224 – Olives</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>224 – Olives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>24 – Agriculture mosaics</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>3 – Grassland and shrubs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>31 – Meadows and pastures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>311 – Meadows</td>
<td>312 – Pastures</td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>32 – Wooded grasslands and shrubs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>33 – Dwarf pine</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>4 – Forest</td>
<td>40 – Boreal forest</td>
<td>401 – Wet forest</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td>402 – Dry forest</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>5 – Wetlands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>6 – Water</td>
<td>61 – Standing waters</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>7 – Bare land</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>71 – Natural rock</td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>72 – Quarries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>73 – Glaciers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>II</td>
<td>74 – Beaches</td>
<td></td>
</tr>
</tbody>
</table>