HERCULES

Sustainable futures for Europe's HERitage in CULtural landscapES: Tools for understanding, managing, and protecting landscape functions and values

GA no. 603447

D3.2 Compiled timelines of cultural landscape change for the study landscapes

Main authors:
Anu Printsmann and Juraj Lieskovský

With contributions from
Matthias Bürgi, Laurence Le Du-Blayo, María García Martín, Kim von Hackwitz, Pip Howard, Thanasis Kizos, Matthias Müller, Sander Rautam, Manuela Schmutz, Heleri Soolmann and Taavi Taavita

Reviewers: Peter Howard

Work package	WP3 Landscape-scale case studies (short-term history)			
Deliverable nature	Report			
Dissemination level (Confidentiality)	Public			
Estimated indicated person-months	17			
Date of delivery	Contractual	31 May 2015	Actual	02 June 2015
Version	1			
Total number of pages	73			
Keywords	Study municipality, land use analysis, land cover analysis			

Executive summary

Work package (WP) 3 aim is to reconstruct and assess the short-term past changes and dynamics of cultural landscapes, using case study approach. As a more detailed analysis can be carried out in smaller spatial scale, Study Municipalities (SM) were distinguished within Study Landscapes (SL).

The aim of this deliverable is to present the results of the task of "Compiled timelines of cultural landscape change (CTCLC)" based on land use / land cover (LULC) change analysis of maps and aerial images since mid-19th century from scales 1:10,000 – 1:50,000 digitised and generalised to 1:50,000 level.

The variety of available maps, scales and level of detail for each SM in different natural, physical, political, social and cultural environment is enormous and does not justify cross-SM comparisons on LULC level. Still, some individual conclusions for CTCLC for specific SM can be drawn:

1. Estonia: SL – Vooremaa and Kodavere, SM – Alatskivi and Peipsiääre. Constant struggle with amelioration has reduced the area of wetlands remarkably promoting forest in a marginalised area where otherwise the landscape has been quite stable: massive forest with mosaic village landscapes.
2. Greece: SL – Lesvos, SM – Gera. The most remarkable change from 1960 to 2012 has been the decline of agriculture whereas the grassland and shrubs, especially wooded grasslands and shrubs taking over based on mapping categories. Also the forest and built-up areas are increasing as is the road network. Probably the processes of modernisation and tourist influx have had impact on abandoning agriculture, which in turn may negatively affect tourism industry that is in search for traditional olive landscapes.
3. Switzerland: SL – Obersimmental, SM – Lenk. With the glaciers melting away bare natural rock area grows slowly. No agriculture. Built-up area grows slowly. Grassland and shrubs are decreasing and forest increasing, both fragmented. Linear infrastructures have been modernised from main roads, railways to cable cars. It seems to be a rather natural landscape with forest overgrowth.
4. Spain: SL – Sierra de Guadarrama foothills, SM – Colmenar Viejo. 1946 seems to be the crucial year, agriculture was in large amounts substituted with grasslands and shrubs; forest almost clear cut. Built-up area and quarries spread as it is situated NW from Madrid. The landscape is criss-crossed with infrastructures: highways, railways and channels. A peri-urban landscape that is in constant change.
5. Sweden: SL – Uppland, SM – Börje. Changes in the vicinity of Uppsala city do not seem radical at all. Scattered mosaic land use seems to have found its peri-urban equilibrium, if this is a possibility. Typical mature polarisation is slowly under way: more monolithic fields appear and grasslands and shrubs are taking over – perhaps as the urban way of life creeps into the countryside leaving fields aside, or more eco-aware attitudes have emerged.

CTCLC based on LULC change analysis is not landscape, thus this outcome will serve as a basis for "objective" background against which comparison of other methods (e.g. oral history interviews (OHI), major events and driving forces (DF) analysis, public participatory GIS (PP-GIS), terrestrial photos etc.) can be done forming Landscape change trajectories (LCT) as case study approach. The mapping exercise results will be uploaded to Knowledge Hub (KH).

Table of contents

List of figures and list of tables

List of figures

20. Colmenar Viejo land use / land cover change in II legend level by years.
21. Colmenar Viejo land use / land cover change in III legend level by years.
22. Density (m/ha) of linear features in I legend level land use / land cover category by years.
23. Number of areal features in I legend level land use / land cover category by years.
24. Area (km^2) of areal features in I legend level land use / land cover category by years.
25. Börje land use / land cover change in I legend level by years. No big change has happened in the shares of agriculture and forest. Built-up areas are slowly increasing preserving the scattered mosaic appearance. When 1861 grasslands and shrubs formed quite a share in landscape, their area diminished during the 20^{th} century and sees a small rise in 21^{st}, perhaps as urban way of life creeps into countryside leaving fields aside or more eco-aware attitudes have emerged.

List of tables

19. The composite legend of linear features for Colmenar Viejo.
20. The total number of linear features and their characteristics in every distinguished land use / land cover category by years.
21. The composite legend of areal features for Börje.
22. The total number and area (km^2) of areal features in every distinguished land use / land cover category by years.
23. The total number of areal features and their characteristics in every distinguished land use / land cover category by years.
24. The composite legend of linear features for Börje.
25. The total number of linear features and their characteristics in every distinguished land use / land cover category by years.

Abbreviations

3D – Three dimensional

CTCLC – Compiled timelines of cultural landscape change

DF – Driving forces

ESRI – Environmental Systems Research Institute

GDB – Geodatabase

GIS – Geographic Information System

KH – Knowledge Hub

LC – Land cover

LCT – Landscape change trajectory

LULC – Land use / land cover

MS – MicroSoft

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

Work package (WP) 3 aim is to reconstruct and assess the short-term past changes and dynamics of cultural landscapes, using case study approach.

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

1. Estonia: Study Landscape (SL) – Vooremaa and Kodavere, Study Municipality (SM) – Alatskivi and Peipsiääre.
2. Greece: SL – Lesvos, SM – Gera.
3. Switzerland: SL – Obersimmental, SM – Lenk.
4. Spain: SL – Sierra de Guadarrama foothills, SM – Colmenar Viejo.
5. Sweden: SL – Uppland, SM – Börje.

This deliverable is dedicated to the second task, which is to compile timelines of cultural landscape change (CTCLC) based on land use / land cover (LULC) change analysis of maps and aerial images since mid-19th century from scales 1:10,000 – 1:50,000 digitised and generalised to 1:50,000 level. As a more detailed analysis can be carried out in smaller spatial scale, SMs were distinguished within SLs.

This report lays down the fundamental "ontological pole of realism" (Anderson 2004: 254) – that there *is* a "real physical world" out there, in the form or lying (distorted) maps (Harley 1989, Monmonier 1991) common to all and independent of human conceptualisations, to which cross-reference is possible. Maps can be deceitful and caution in interpreting the results is necessary (e.g. Käyhkö and Skånes 2006 and 2008). The literature on Geographic Information System (GIS) based LULC change is vast; there are many specialised journals and conferences dedicated to this topic. For example, what a century ago was considered a shrubbery may be today quite different, e.g. a forest, although the quality of the real life phenomena may not have changed, thus as the specification of the reality model has change because of our perception altering, it creates "reversals of ecological matrix" what in real life may not have happened. The borders of mapping units in real life may be quite subjective, e.g. shrubberies, wet forest etc. Additionally, changing polities with different ideologies stressing different values and more precise technologies add to impreciseness.

Being wary of the perils in cartographic endeavours, the process of receiving CTCLC based on LULC change analysis was carried out as follows being dealt more in-depth in the Methodology chapter:

1. SM were selected previously (see Deliverable 3.1),
2. spatial data availability questionnaire was carried out among SL coordinators (SLC) to select the best maps for our purpose,
3. maps were gathered with the help of SLCs,
4. when needed, maps were georeferenced or used the right projections for Web Map Service (WMS) providers,
5. determining the suitable legend for each SM,
6. the on-screen digitalisation,
7. topology check,
8. eliminating mistakes,
9. brief statistics.

The mapping exercise results will be uploaded to the HERCULES Knowledge Hub (KH).

The variety of available maps, scales and level of detail for each SM in different natural, physical, political, social and cultural environment is enormous and does not justify cross-SM comparisons on LULC level but provide basis for grasping change, especially for a researcher whose SM is not his/her home landscape, e.g. for OHI and *vice versa*: whether perceived landscape change for more monotonous can be read out from landscape metrics (there are positively too many landscape ecology indices to be calculated beforehand).

CTCLC based on LULC change analysis is not landscape, thus this outcome will serve as a basis for "objective" background against which comparison of other methods, e.g. oral history interviews (OHI), major events and driving forces (DF) analysis, public participatory GIS (PP-GIS), terrestrial photos, 3D diagrams etc. can be done forming Landscape change trajectories (LCT) (compare to path dependency in landscapes, e.g. Zariņa 2013) as case study approach, eventually leading to tasks three and four (Assessment of driving forces and actors and Comparative analyses, respectively). The overall outcome should be enhanced understanding of *perceived* landscape change and improving comparative methods for achieving that.

2 Methodology

The SMs for the CTCLC based on LULC change analysis were selected previously for their smallness as cartographic analysis on detailed level for areas over 15,000 km^2 is not reasonable (table 1).

Table 1. The characteristics of Study Landscapes and Study Municipalities.

Country	Study Landscape	Area (km^2)	Study Municipality	Area (km^2)
Estonia	Vooremaa and Kodavere	1917.89	Alatskivi, Peipsiääre	128.51, 31.92
Greece	Lesvos	1638.97	Gera	86.68
Switzerland	Obersimmental	334.04	Lenk	126.15
Spain	Sierra de Guadarrama foothills	835.14	Colmenar Viejo	182.98
Sweden	Uppland	17988.27	Börje	46.62

In the following a brief overview of work flow will be given:

1. overview of spatial data availability questionnaire,
2. description of map selection procedure,
3. time layers of maps,
4. legend development,
5. digitalisation method and
6. results.

2.1 Overview of spatial data availability questionnaire

The spatial data availability questionnaire was quite thorough (annex 1) and some answers reached up to 18 pages.

Estonia

For the 20th century the map availability for LULC change analysis have remained quite the same throughout the studies (Palang et al. 1998, Peterson and Aunap 1998 etc.):

1. the so-called verst map from czarist Russia,
2. previous independent interwar period of Estonia,
3. soviet maps of 1980s that were state secret at that time,
4. maps of re-independent Estonia with the revolution of desktop mapping, satellite imagery, orthophotos etc.

Many of these maps are made readily available for everyone by Estonian Land Board Web Map Server (http://geoportaal.maaamet.ee/eng) offering also WMS. There is no overall mapping exercise for the 19th century, each manorial (landed) estate ordered the maps when they saw fit and these are scattered in analogue form in many archives in Estonia, Latvia, Russia, Germany and Sweden. Some electronic search options are available but the map scales are usually above determined by the project.

Greece

For Greece, as the SL is in the border zone, the maps are confidential and for limited use. There are topographic maps of 1:50,000 and 1:5000 from 1972, aerial photos from 1961, additionally geology map of 1:200,000 from 2010 and agriculture and animal husbandry

censuses 1951–2011. Current aerial images are available via Environmental Systems Research Institute's (ESRI) GIS program ArcGIS basemaps.

Switzerland

Map production started early in some parts of Switzerland. In the mid-19th century the project of a nationwide map was realized with the Dufour map. This map was widely acknowledged for its preciseness and clarity. An even more detailed map was published from 1870 to 1926 (scale 1:25,000) which was called Siegfried map. The Siegfried map was produced in general on the same data basis as the Dufour map with additional verifications and corrections on the data. The decision to make a new map series was taken in 1935. This new map series is called Landeskarte. The map sheets were renewed regularly and since the 1990s there is also a digital version of these maps.

All the maps can be purchased at the Federal Office of Topography Swisstopo and are available at Swiss Federal Institute for Forest, Snow and Landscape Research.

Spain

From the 1850s till the 1950s there are about five topographical historical maps available with scales between 1:2000 and 1:50,000. Since the 1960s there are more than 20 topographical maps from different years and at different scales (1:5000, 1:10,000, 1:25,000 and 1:50,000), listed on the cartographical catalogue of the regional government (Comunidad de Madrid). The orthophotos start from 1946, aerial photos from 1972, satellite imagery since 1984 that are usually both on analogue and digital form with a small price. Additionally, there are plenty of environmental units, vegetation, agrological, forest etc. maps.

In Colmenar Viejo there are two initiatives collecting historical photos: the Association "Asociación Cultural Pico de San Pedro", which has published a catalogue "Retrato de un pueblo", and a FaceBook group "Colmenar Viejo hace…" where the citizens upload old photos they have (https://www.youtube.com/watch?v=1yR-0-lXu1E).

There are also some books available in Spanish (Arístegui Cortijo 2013, La Dehesa del Colmenar 1991, Sabau Bergamin 2002).

Sweden

Many Swedish maps have lower scales than this project requires. For example the cadastral map for SM Börje was made in 1635. The online search engine gave 64 maps for Börje up to 1945. Aerial photos are available from the 1930s, satellite imagery since the 1970s, many also by WMS that requires permits.

Historical maps from the Ordnance Survey (Swedish *Lantmäteriet*): http://historiskakartor.lantmateriet.se/arken/s/search.html.

On the improvements in agrarian techniques that have always caused changes in the organisation and morphology of the agrarian cultural landscape (the *storskifte*, *enskifte* and *laga skifte*) in Sweden see Helmfrid 1961.

2.2 Description of map selection procedure

To have the best possible LULC maps, we combined different sources of the information from the cartographical maps, aerial pictures, OpenStreetMaps, parcel maps, ESRI's ArcGIS

basemaps, (historical) Google Earth and others. The mapping sources were selected according to five criteria.

1. Thematic resolution: to be able to compare the different maps, we set up a common hierarchical legend (see chapter 2.4 Legend). We selected only those maps that distinguished at least 7 main area classes (Urban / Built-up, Agriculture, Grassland and shrubs, Forest, Wetlands, Water, Bare land) and 4 main linear classes (Water, Roads, Railway, Cable car).
2. Spatial resolution: minimum level of spatial resolution was set up to scale 1:50,000. To have a comparable dataset we generalised more detailed maps to the level of the less detailed map from the SM (usually the oldest map).
3. Time resolution: the idea was to digitise the maps that reflect substantial changes in the landscape. We had the information about the history of the area from the list of major events provided by SLC. Since the speed of landscape changes was increasing over the last century, we used shorter time spans between the digitised time layers for the last decades.
4. Actuality: not every mapset is based on a cartographic survey. Some maps are just reprints of older maps, where some substantial changes (chosen according to purpose of the map) were actualised and rest of the map reflects the situation from the time of original cartographic survey. To avoid the use of not actual re-printed maps, we compared the mapsets from different time periods and always checked the map originality and actuality.
5. Availability: the ideal case of map selection was to have the maps with the same thematic and spatial resolution that are updated after each substantial change in the landscape. Of course, the reality was different and we were limited by availability of the maps. If the map was not available for desired time, we choose the best available map. The problem with map's availability was limiting especially for the maps before 1950.

2.3 Time layers of maps

The result of the complicated spatial data availability and map selection procedure is presented in figure 1. The mapping years in this project may imply to more radical changes in the landscape as described in the map selection procedure, e.g. the II World War and polities.

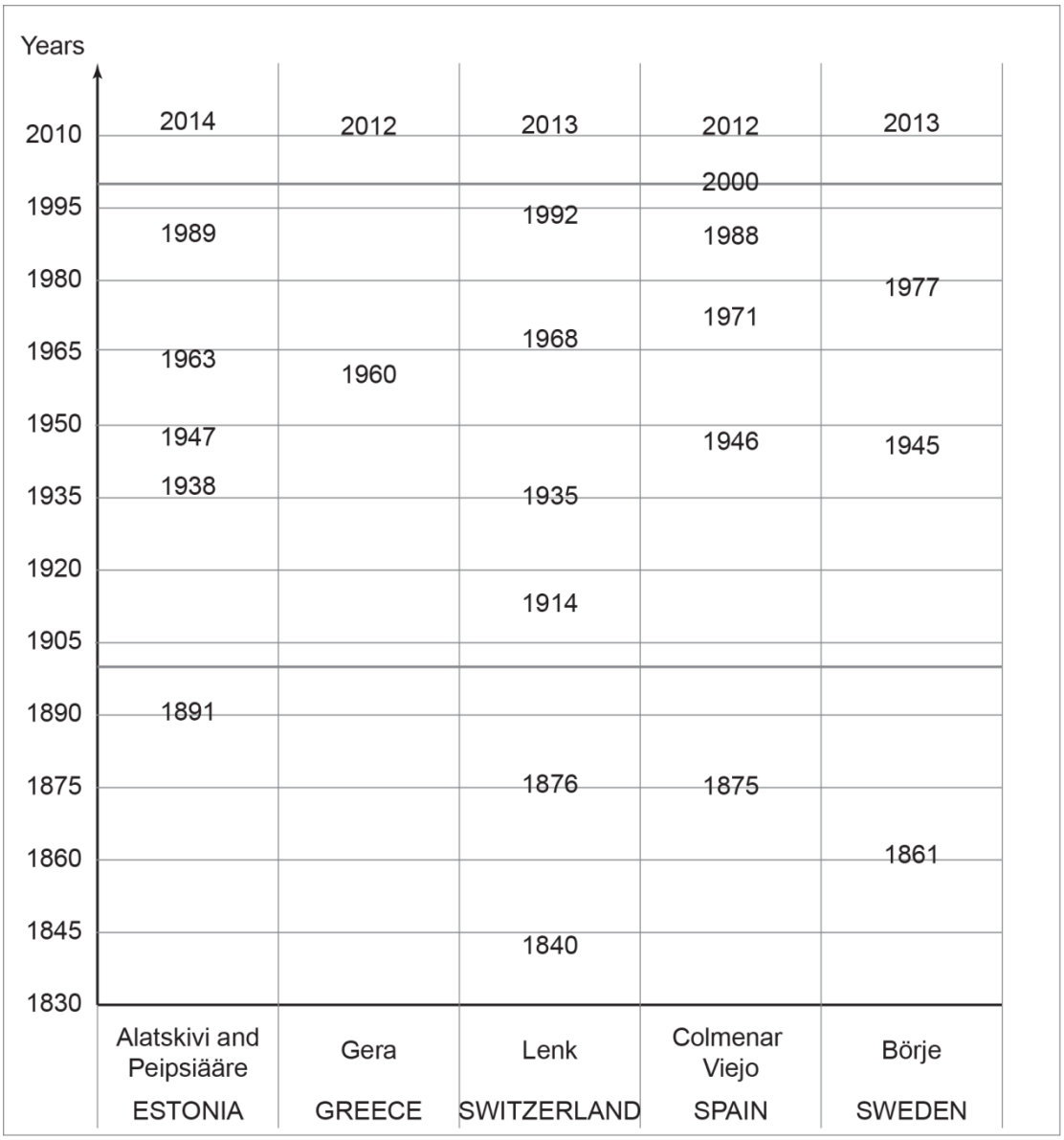


Figure 1. The time layers of maps used for Compiled timelines of cultural landscape change based on land use / land cover change analysis.

2.4 Legend

The designation of the legend was based on experiences from the project "200 years of land use and land cover changes and their driving forces in the Carpathian Basin". The aim of the project was to map the long term LULC changes in the Carpathians and adjacent Carpathian Basin. The hierarchical categorisation of the legend entries (tables 2 and 3) enables to map and compare the sources with different thematic resolution. Additionally, the main areal classes are compatible with the LC mapped from the satellite images in WP4.

Table 2. The composite legend of areal features for all Study Municipalities.

Legend level	I legend level category code and explanation	II legend level category code and explanation	III legend level category code and explanation
I	1 – Urban / Built-up		
I	2 – Agriculture		

II		21 – Seasonal agriculture	
III			211 – Arable land
III			212 – Vegetable gardens
II		22 – Perennial agriculture	
III			221 – Orchards
III			222 – Vineyards
III			224 – Olives
		24 – Agriculture mosaics	
I	3 – Grassland and shrubs		
II		31 – Meadows and pastures	
III			311 – Meadows
III			312 – Pastures
II		32 – Wooded grasslands and shrubs	
II		33 – Dwarf pine	
I	4 – Forest		
II		40 – Boreal forest	
III			401 – Wet forest
III			402 – Dry forest
II		43 – Evergreen forest	
I	5 – Wetlands		
I	6 – Water		
II		61 – Standing waters	
I	7 – Bare land		
II		71 – Natural rock	
II		72 – Quarries	
II		73 – Glaciers	
II		74 – Beaches	

For a specific legend for each SM see the Results under each SM, also annexes 2–6.

Table 3. The composite legend of linear features for all Study Municipalities.

Legend level	**I legend level category code and explanation**	**II legend level category code and explanation**
I	1 – Water	
II		11 – Rivers
II		12 – Streams
II		13 – Channels
I	2 – Roads	
II		21 – Main roads
II		22 – Side roads
II		23 – Pathways
II		24 – Highways
I	3 – Railways	
I	4 – Cable cars	

None of the countries has all seven of the I legend level categories (table 4). By the respective SMs it is interesting to follow what categories and sub-categories have been important enough to be distinguished throughout the history, e.g. agricultural lands as more economically profitable are mapped with more detail than for example forests and wetlands.

Of course such a generalised legend has many shortcomings. For 1:50,000 maps gardens within built-up area may get lost. The allocation of meadows and pastures outside agricultural areas and other peculiarities are inherited from the adopted previously worked-out proposal that fits to all WPs.

Table 4. Level of detail of the legend for each Study Municipality.

Study Municipality	Map layers	Areal features' categories			Linear features' categories	
		Legend level			Legend level	
		I	II	III	I	II
Alatskivi, Peipsiääre	6	6	5	4	2	6
Gera	2	5	6	1	2	3
Lenk	7	6	5	-	4	3
Colmenar Viejo	6	5	7	6	3	6
Börje	4	5	-	-	3	6

For linear features water and road networks can be found everywhere whereas railways and especially cable car become rarer. Again, different attention has been paid in different countries in different time periods to the level of detail of water and road networks.

2.5 Digitalisation method

To minimise the spatial inaccuracy's errors, the time layers were not digitised separately but adopted the back-dating approach instead. Firstly, the current (most precise) layer was digitised. For the older layers the boundaries were re-drawn only if the change really happened (not if the change is the result of map's inaccuracies). The different spatial resolution of the maps was dealt by constantly checking the least detailed map. Usually the linear features were digitised before areal features.

The digitalisation took place with ESRI's GIS program ArcGIS.

Topology check was done in geodatabase (GDB) and legend inconsistencies in MicroSoft (MS) Excel.

3 Results

The results are presented by SMs and by areal and linear features.

For areal features by using the GIS technologies, it is possible to determine for each legend level the number of features in them and other characteristics very easily:

1. deriving from the area of each feature:
   a) minimum value, i.e. the size of the smallest feature,
   b) maximum value, i.e. the size of the largest feature,
   c) sum of all the features, i.e. the total sum of the area,
   d) mean value, i.e. the medium plot size,
   e) standard deviation showing the amount of variation,
2. deriving from the perimeter of each feature:
   a) minimum value, i.e. the shortest perimeter,
   b) maximum value, i.e. the longest perimeter,
   c) sum of all the features, i.e. the total length of perimeters,
   d) mean value, i.e. the medium perimeter,
   e) standard deviation showing the amount of variation.

For linear features for each legend level the number of features in them and other characteristics were determined:

1. deriving from the length of each feature:
   a) minimum value, i.e. the shortest line,
   b) maximum value, i.e. the longest line,
   c) sum of all the features, i.e. the total length of lines,
   d) mean value, i.e. the medium length,
   e) standard deviation showing the amount of variation,
   f) line density (m/ha).

Considering the:

1. three-tier hierarchical legend,
2. up to seven yime layers of maps,
3. number of characteristics,
4. metrics calculations are not done manually,
5. all the GIS GDB and MS Excel table formats will be made available for HERCULES project participants and publicly by KH,

only the small and overview tables are given in this report.

3.1 Estonia – Vooremaa and Kodavere – Alatskivi and Peipsiääre

Areal features

Estonian areal features legend is quite elaborate (table 5).

Table 5. The composite legend of areal features for Alatskivi and Peipsiääre.

Legend level	I legend level category code and explanation	II legend level category code and explanation	III legend level category code and explanation
I	1 – Urban / Built-up		
I	2 – Agriculture		

II		21 – Seasonal agriculture	
III			211 – Arable land
I	3 – Grassland and shrubs		
II		31 – Meadows and pastures	
III			311 – Meadows
II		32 – Wooded grasslands and shrubs	
I	4 – Forest		
II		40 – Boreal forests	
III			401 – Dry forest
III			402 – Wet forest
	5 – Wetlands		
I	6 – Water		
II		61 – Standing waters	

The number of areal features shows a steady increase (table 6, figures 2–6).

1. Built-up area has decreased as it is a marginal area, contemporary maps present better mapping possibilities.
2. Agriculture presents the same trend as built-up area.
3. Grassland and shrubs were taken over by mid-20th century; the decline now can be explained by forest overgrowth.
4. Forest is the main LULC category.
5. The number and area of wetlands has decreased.
6. Water bodies have remained constant.

Table 6. The total number and area (km^2) of areal features in every distinguished land use / land cover category by years.

Legend level	**Category**	**Features / area (km^2)**					
		1891	**1938**	**1947**	**1963**	**1989**	**2014**
I	**1**	**81/17.22**	**123/27.02**	**188/19.88**	**173/18.79**	**174/18.92**	**182/15.32**
I	**2**	**52/36.08**	**47/34.67**	**56/40.97**	**66/45.10**	**72/41.24**	**92/34.45**
II	21	52/36.08	47/34.67	56/40.97	66/45.10	72/41.24	92/34.45
III	211	52/36.08	47/34.67	56/40.97	66/45.10	72/41.24	92/34.45
I	**3**	**60/25.20**	**95/36.33**	**117/38.94**	**76/31.48**	**143/17.40**	**95/12.50**
II	31	27/8.65	38/14.93	52/7.76	18/4.23	38/3.38	13/1.79
III	311	27/8.65	38/14.93	52/7.76	18/4.23	38/3.38	13/1.79
II	32	33/16.55	57/21.39	65/31.18	58/27.25	105/14.02	82/10.71
I	**4**	**51/52.70**	**45/44.44**	**51/38.37**	**82/52.72**	**83/70.17**	**93/94.31**
II	40	51/52.70	45/44.44	51/38.37	82/52.72	83/70.17	93/94.31
III	401	32/30.08	28/27.33	38/25.95	46/29.45	49/44.04	80/92.34
III	402	19/22.61	17/17.11	13/12.42	36/23.28	34/26.13	13/1.97
I	**5**	**39/27.36**	**54/16.45**	**76/20.74**	**28/10.35**	**38/10.59**	**32/2.37**
I	**6**	**5/1.82**	**5/1.83**	**4/1.49**	**4/1.52**	**4/1.70**	**5/1.75**
II	61	5/1.82	5/1.83	4/1.49	4/1.52	4/1.70	5/1.75
		288	**369**	**492**	**429**	**514**	**499**

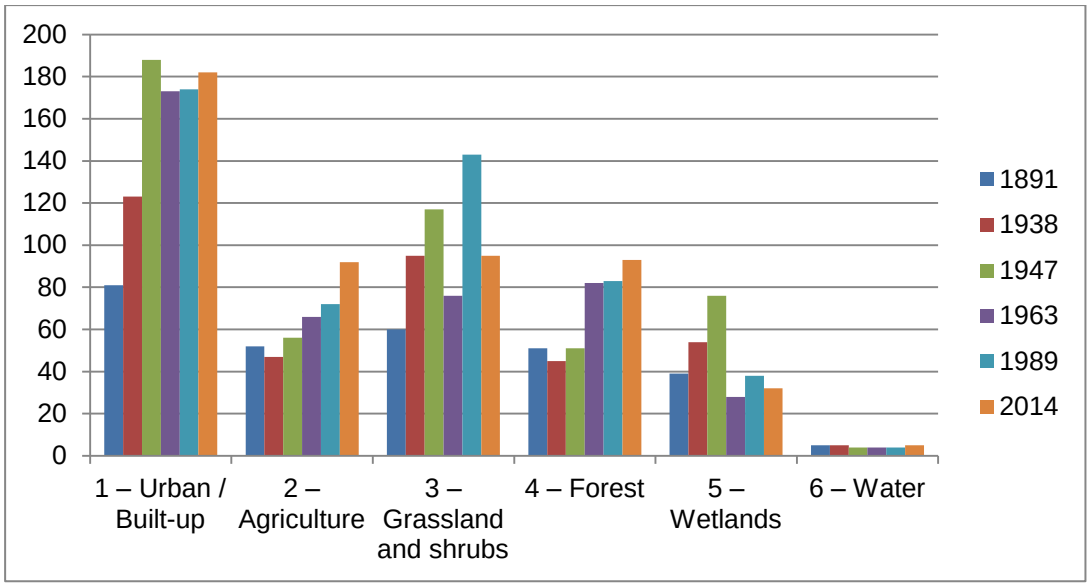


Figure 2. Number of areal features in I legend level land use / land cover category by years.

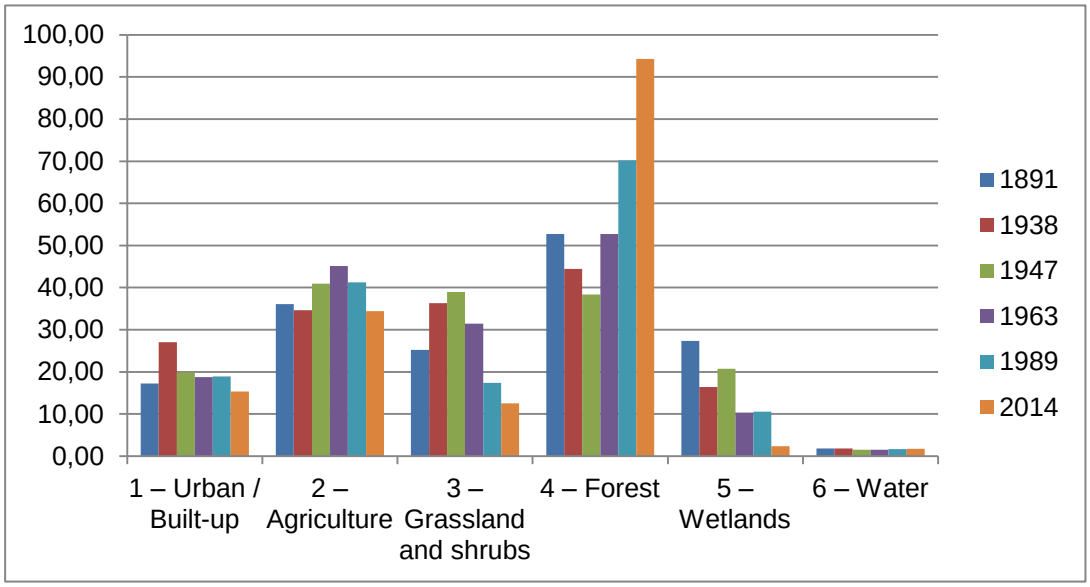


Figure 3. Area (km^2) of areal features in I legend level land use / land cover category by years.

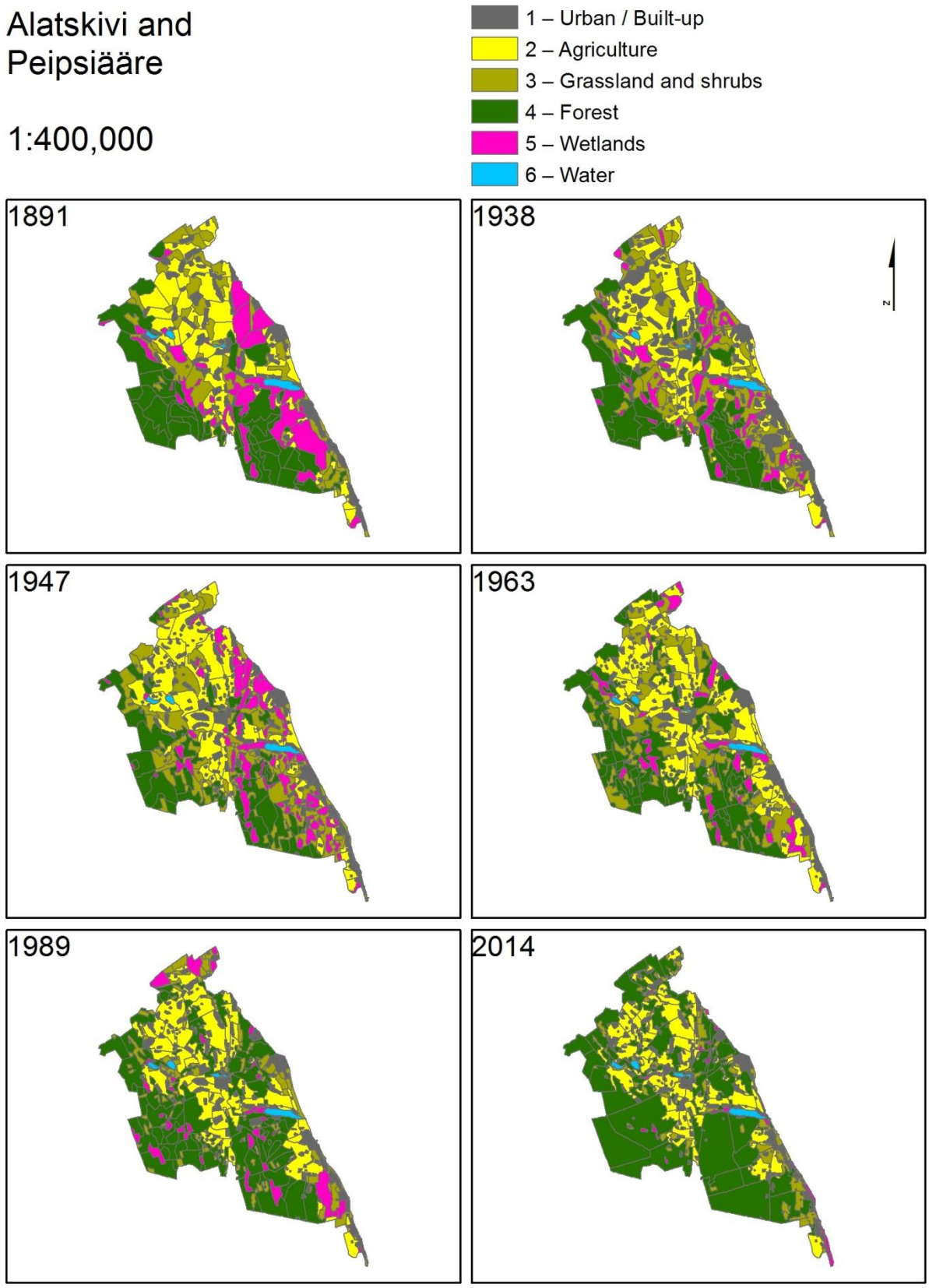


*Figure 4. Alatskivi and Peipsiääre land use / land cover change in I legend level by years.*The most remarkable change has been the near elimination of wetlands, although it is a difficult phenomena to map – agricultural lands, meadows and pastures, wooded grasslands and shrubs, forest and even built-up areas – all may become too moist. Setting up sustainable drainage has been a goal for nearly 150 years. As east to the SM is Lake Peipsi then the shore

parts that are not wetlands are used for living. Otherwise the landscape has been quite stable: massive forest with mosaic village landscapes.

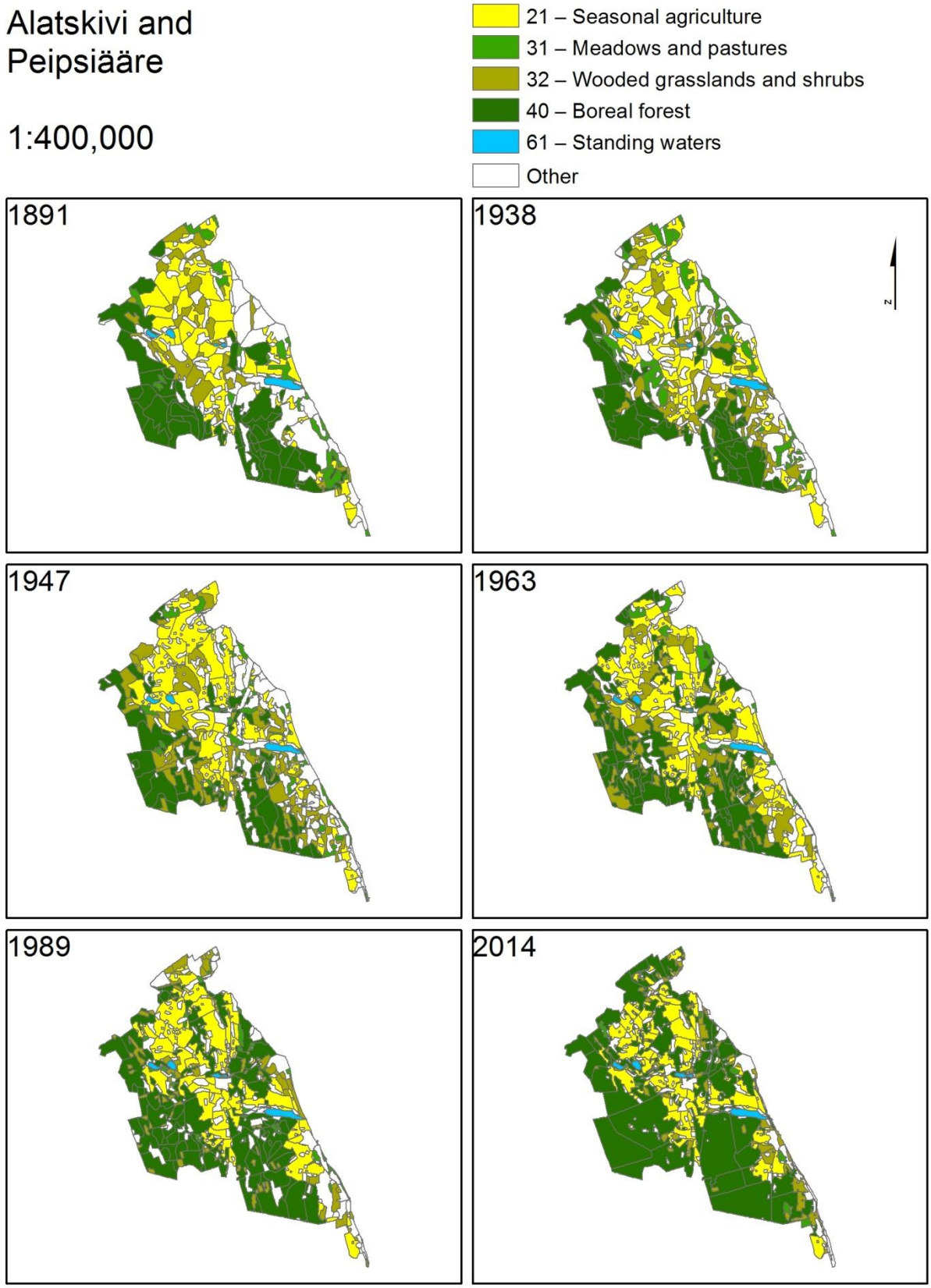


Figure 5. Alatskivi and Peipsiääre land use / land cover change in II legend level by years.

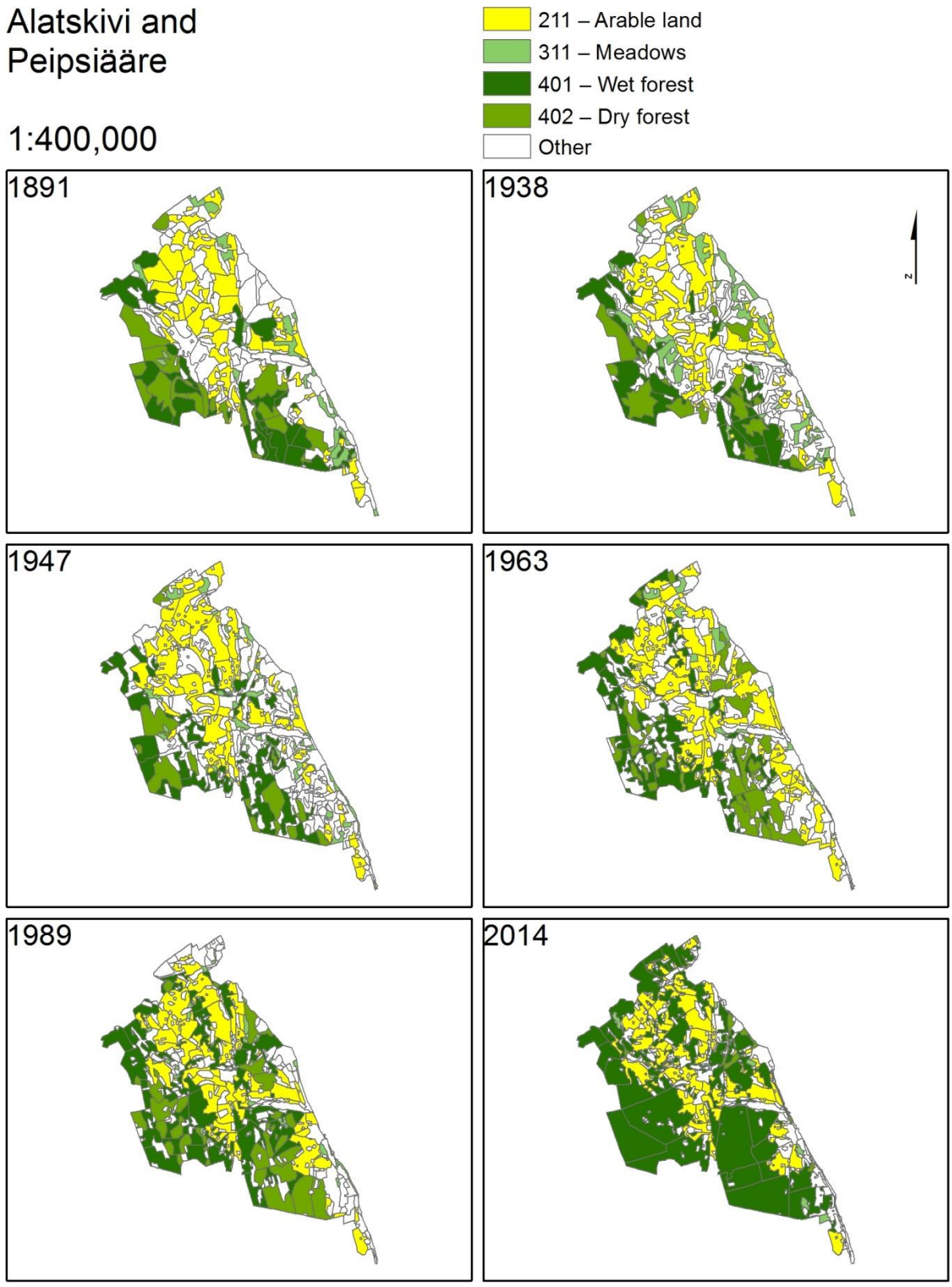


Figure 6. Alatskivi and Peipsiääre land use / land cover change in III legend level by years.

Linear features

The composite legend of linear features for Alatskivi and Peipsiääre is quite similar to other SMs with the exception of missing highways and railways (table 7).

Table 7. The composite legend of linear features for Alatskivi and Peipsiääre.

Legend level	I legend level category code and explanation	II legend level category code and explanation
I	1 – Water	
II		11 – Rivers
II		12 – Streams
II		13 – Channels
I	2 – Roads	
II		21 – Main roads
II		22 – Side roads
II		23 – Pathways

The densities for water and road network have generally risen throughout the period (table 8 and figure 7).

Table 8. The total number of linear features and their characteristics in every distinguished land use / land cover category by years.

Year	Legend level	Category	Features	Length (m)					Density (m/ha)
				Min	Max	Sum	Mean	SD[1]	
1891	**I**	**1**	**19**	**365**	**5284**	**39439**	**2076**	**1502**	**2.46**
	II	11	11	593	5284	27347	2486	1751	1.70
	II	12	4	365	2394	4178	1045	796	0.26
	II	13	4	1536	2359	7914	1979	354	0.49
	I	**2**	**52**	**520**	**14184**	**142432**	**2739**	**2499**	**8.88**
	II	21	17	520	14184	73149	4303	3709	4.56
	II	22	25	735	3955	51369	2055	879	3.20
	II	23	10	615	3534	17914	1791	963	1.12
1938	**I**	**1**	**20**	**574**	**5284**	**44550**	**2227**	**1418**	**2.78**
	II	11	12	574	5284	31497	2625	1684	1.96
	II	12	2	1452	2248	3699	1850	398	0.23
	II	13	6	1109	2359	9354	1559	413	0.58
	I	**2**	**59**	**230**	**15553**	**147726**	**2504**	**2510**	**9.21**
	II	21	19	520	15553	74537	3923	3891	4.65
	II	22	18	230	3229	34500	1917	803	2.15
	II	23	22	602	3955	38689	1759	846	2.41
1947	**I**	**1**	**82**	**47**	**7225**	**127961**	**1560**	**1227**	**7.98**
	II	11	30	416	7225	66236	2208	1573	4.13
	II	12	6	1119	2618	11324	1887	546	0.71
	II	13	46	47	3629	50401	1096	726	3.14
	I	**2**	**127**	**10**	**15620**	**221405**	**1743**	**1992**	**13.80**
	II	21	40	106	15620	86804	2170	3185	5.41
	II	22	63	10	4563	101970	1619	1101	6.36
	II	23	24	359	2770	32631	1360	642	2.03
1963	**I**	**1**	**99**	**30**	**5711**	**130924**	**1322**	**1070**	**8.16**
	II	11	33	347	4820	55342	1677	1153	3.45
	II	12	8	750	5711	18001	2250	1449	1.12
	II	13	58	30	3672	57581	993	781	3.59
	I	**2**	**164**	**10**	**15381**	**214245**	**1306**	**1888**	**13.35**

	II	21	41	106	15381	85344	2082	3149	5.32
	II	22	83	10	7391	85750	1033	1273	5.34
	II	23	40	20	2199	43151	1079	515	2.69
1989	**I**	**1**	**195**	**30**	**4820**	**179115**	**919**	**756**	**11.16**
	II	11	33	36	4820	44238	1341	1068	2.76
	II	12	11	174	3534	14935	1358	950	0.93
	II	13	151	30	3672	119943	794	595	7.48
	I	**2**	**73**	**209**	**14801**	**177312**	**2429**	**2425**	**11.05**
	II	21	37	551	14801	122380	3308	3015	7.63
	II	22	25	209	5503	40515	1621	1153	2.53
	II	23	11	916	1891	14418	1311	316	0.90
2014	**I**	**1**	**143**	**30**	**5131**	**221917**	**1552**	**997**	**13.83**
	II	11	26	347	5077	52843	2032	1283	3.29
	II	12	28	373	3745	48312	1725	905	3.01
	II	13	89	30	5131	120761	1357	862	7.53
	I	**2**	**128**	**209**	**9027**	**256921**	**2007**	**1926**	**16.01**
	II	21	22	551	9027	90605	4118	2847	5.65
	II	22	92	209	8270	152739	1660	1363	9.52
	II	23	14	478	1665	13577	970	321	0.85

[1] SD – Standard deviation

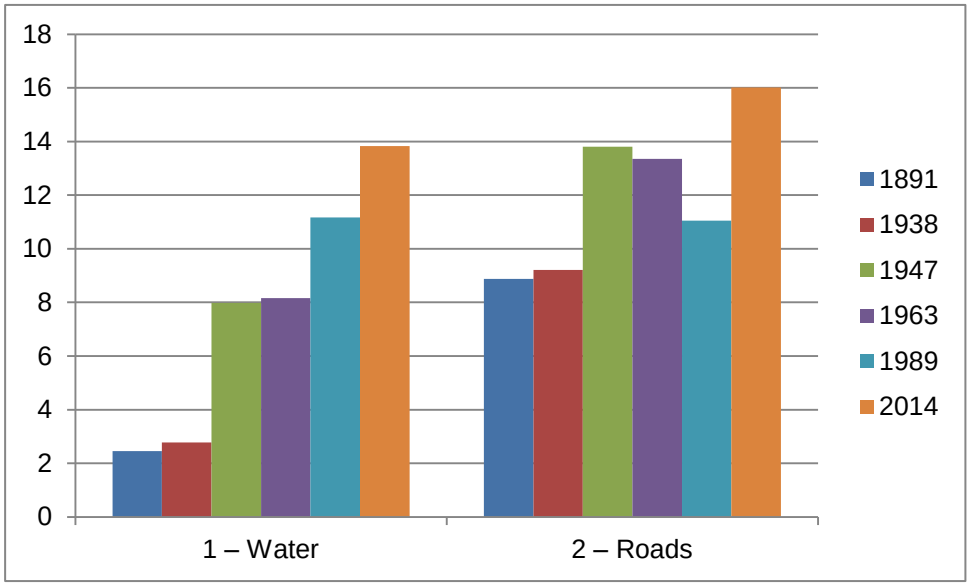


Figure 7. Density (m/ha) of linear features in I legend level land use / land cover category by years.

3.2 Greece – Lesvos – Gera

Areal features

Greece has quite elaborated legend for areal features (table 9) featuring beaches.

Table 9. The composite legend of areal features for Gera.

Legend level	I legend level category code and explanation	II legend level category code and explanation	III legend level category code and explanation
I	1 – Urban / Built-up		

I	2 – Agriculture		
II		22 – Perennial agriculture	
III			224 – Olives
II		24 – Agriculture mosaics	
I	3 – Grassland and shrubs		
II		31 – Meadows and pastures	
II		32 – Wooded grasslands and shrubs	
I	4 – Forest		
I	7 – Bare land		
II		71 – Natural rock	
II		74 – Beaches	

There are too few time layers to make sound conclusions (table 10, figures 8, 9 and 10).

1. Urban / built-up area is increasing.
2. Agriculture is decreasing.
3. Grassland and shrubs are increasing.
4. Forests are increasing.
5. Bare land has remained relatively the same.

Table 10. The total number and area (km^2) of areal features in every distinguished land use / land cover category by years.

Legend level			**Category**	**Features**		**Area (km^2)**	
				1960	**2012**	**1960**	**2012**
I			**1**	**33**	**68**	**4.23**	**5.65**
I			**2**	**103**	**91**	**66.51**	**45.42**
	II		22	82	70	63.37	43.94
		III	224	82	70	63.37	43.94
	II		24	21	21	3.14	1.48
I			**3**	**33**	**48**	**6.04**	**19.84**
	II		31	4	4	0.50	0.15
	II		32	29	44	5.54	19.69
I			**4**	**13**	**31**	**7.86**	**13.02**
I			**7**	**19**	**17**	**1.93**	**2.67**
	II		71	9	9	1.40	2.35
	II		74	10	8	0.53	0.32
				201	**255**	**86.68**	**86.68**

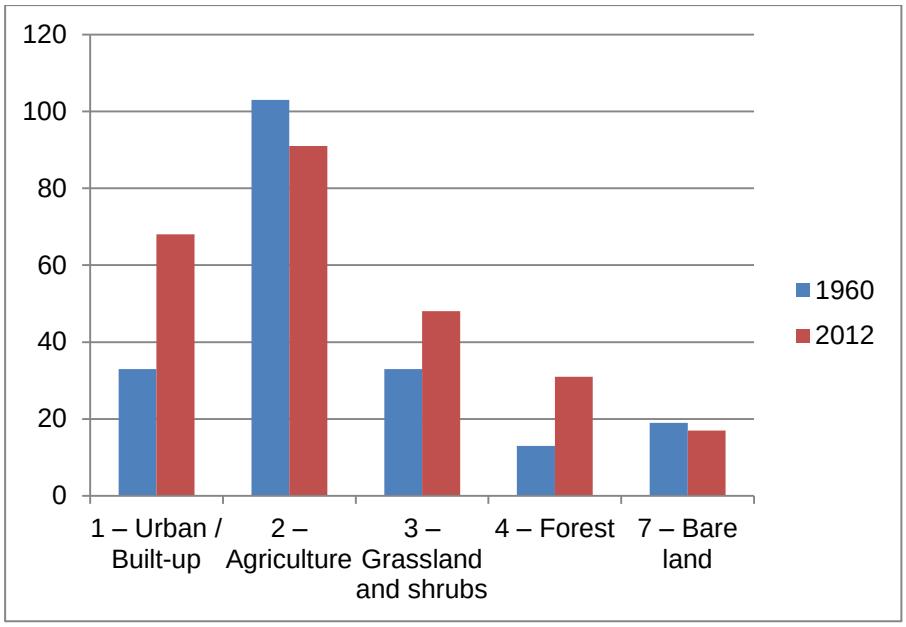


Figure 8. Number of areal features in I legend level land use / land cover category by years.

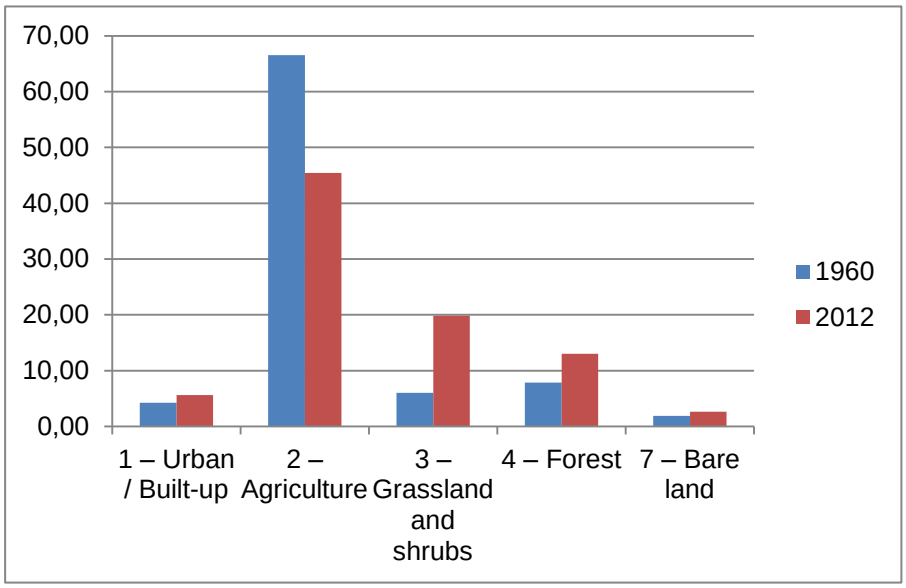


Figure 9. Area (km^2) of areal features in I legend level land use / land cover category by years.

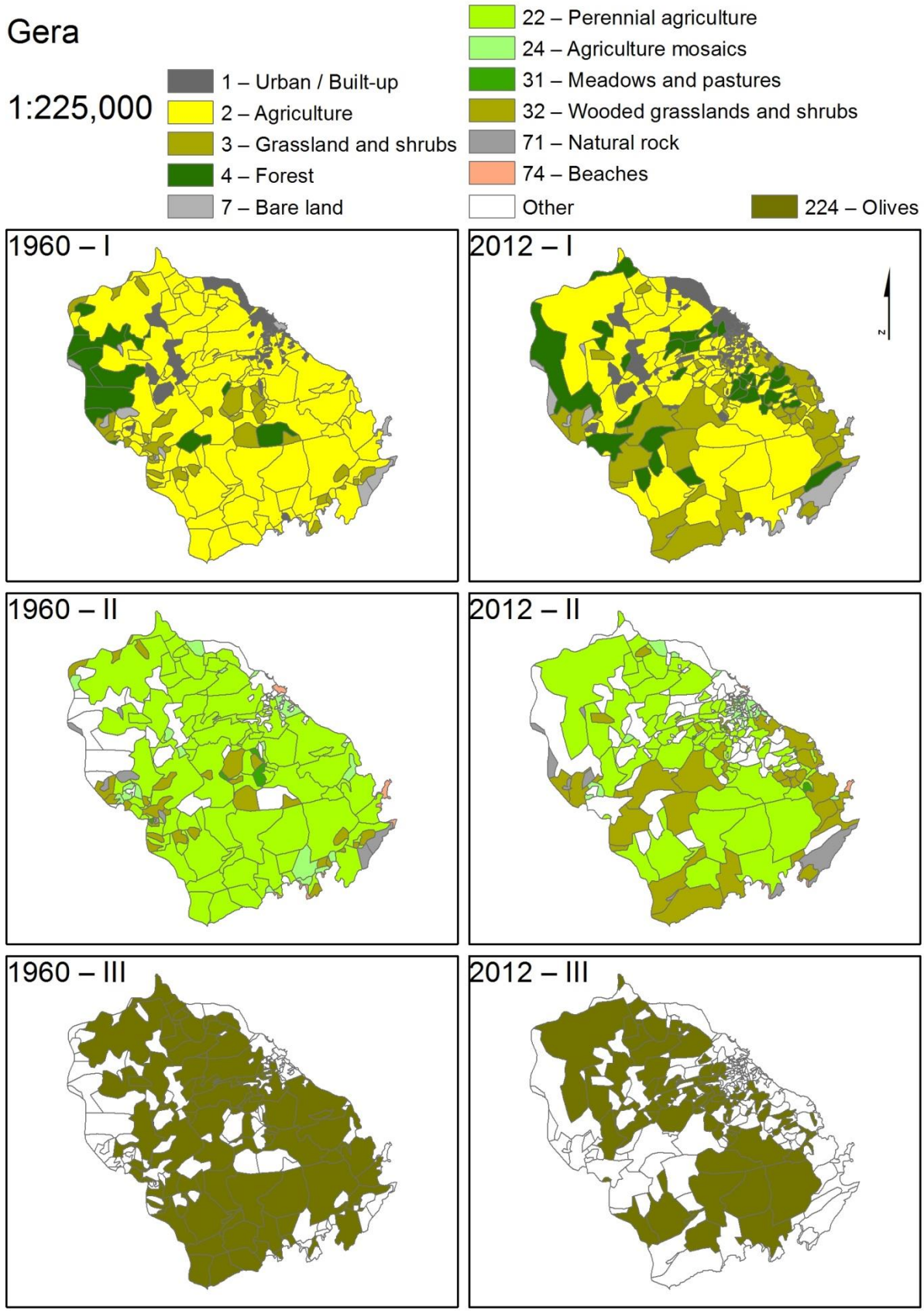


Figure 10. Gera land use / land cover change in I, II and III legend level by years.

Agriculture is being replaced with grassland and shrubs, especially wooded grasslands and shrubs. Also the olive landscape seems to be on decay.

Linear features

The composite legend of linear features for Gera is the shortest one (table 11).

Table 11. The composite legend of linear features for Gera.

Legend level	I legend level category code and explanation	II legend level category code and explanation
I	1 – Water	
II		11 – Rivers
I	2 – Roads	
II		21 – Main roads
II		22 – Side roads

The density of water network has decreased whereas the density of road network has increased (table 12 and figure 11).

Table 12. The total number of linear features and their characteristics in every distinguished land use / land cover category by years.

Year	Legend level	Category	Features	Length (m)					Density (m/ha)
				Min	Max	Sum	Mean	SD[1]	
1960	**I**	**1**	**9**	**765**	**7897**	**26131**	**2903**	**2236**	**3.01**
	II	11	9	765	7897	26131	2903	2236	3.01
	I	**2**	**30**	**257**	**14470**	**91324**	**3044**	**2782**	**10.54**
	II	21	15	257	14470	56707	3780	3715	6.54
	II	22	15	1039	3655	34617	2308	768	3.99
2012	**I**	**1**	**4**	**765**	**7897**	**14858**	**3715**	**3044**	**1.71**
	II	11	4	765	7897	14858	3715	3044	1.71
	I	**2**	**101**	**169**	**12097**	**250892**	**2484**	**2019**	**28.94**
	II	21	12	169	12097	45297	3775	3683	5.23
	II	22	89	198	8083	205595	2310	1594	23.72

[1] Standard deviation

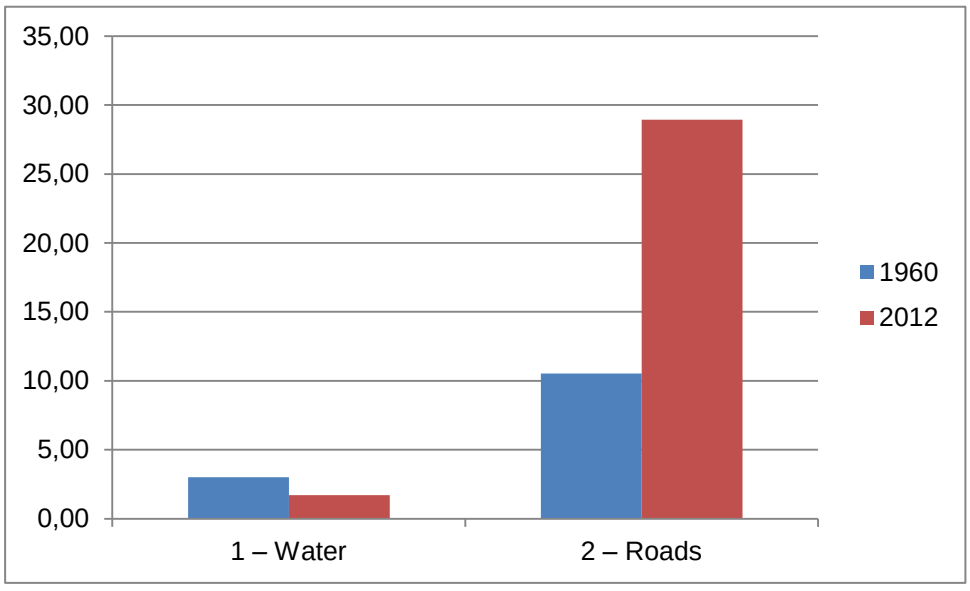


Figure 11. Density (m/ha) of linear features in I legend level land use / land cover category by years.

3.3 Switzerland – Obersimmental – Lenk

Areal features

Switzerland has a legend for areal features (table 13) that does not include agriculture but has bare land, including natural rock and glaciers categories.

Table 13. The composite legend of areal features for Lenk.

Legend level	I legend level category code and explanation	II legend level category code and explanation
I	1 – Urban / Built-up	
I	3 – Grassland and shrubs	
II		31 – Meadows and pastures
II		32 – Wooded grasslands and shrubs
I	4 – Forest	
I	5 – Wetlands	
I	6 – Water	
II		61 – Standing waters
I	7 – Bare land	
II		71 – Natural rock
II		73 – Glaciers

The overall number of features does not present a clear tendency (table 14, figures 12–15).

1. Urban / built-up area shows small increasing trend, especially for number since 1992.
2. The number of grassland and shrubs is increasing but the area is diminishing.
3. Forest is increasing.
4. Wetlands are slowly decreasing.
5. The number and area of water bodies is slowly rising.
6. Bare land is slowly growing by area but the area of glaciers is melting away.

Table 14. The total number and area (km^2) of areal features in every distinguished land use / land cover category by years.

Level	Category	Features / area (km^2)						
		1840	**1876**	**1914**	**1935**	**1968**	**1992**	**2013**
I	**1**	**3/0.05**	**6/0.09**	**7/0.12**	**6/0.12**	**4/0.30**	**16/0.63**	**16/0.75**
I	**3**	**14/79.51**	**48/73.17**	**45/72.00**	**83/70.40**	**51/60.19**	**50/59.54**	**51/59.38**
II	31	14/79.51	22/72.11	21/70.80	26/67.74	34/58.99	33/58.17	32/57.81
II	32	0	26/1.06	24/1.20	57/2.66	17/1.20	17/1.36	19/1.57
I	**4**	**22/3.71**	**112/9.02**	**112/9.07**	**108/9.43**	**86/18.81**	**95/19.24**	**98/19.27**
I	**5**	**15/1.83**	**14/1.37**	**14/1.37**	**14/1.37**	**14/1.37**	**14/1.12**	**13/1.08**
I	**6**	**4/0.14**	**5/0.14**	**8/0.14**	**12/0.19**	**11/0.22**	**11/0.22**	**12/0.24**
II	61	4/0.14	5/0.14	8/0.14	12/0.19	11/0.22	11/0.22	12/0.24
I	**7**	**71/37.95**	**98/39.39**	**97/40.47**	**102/41.66**	**73/42.29**	**69/42.43**	**68/42.45**
II	71	64/20.10	91/23.02	88/25.08	95/26.26	66/30.25	62/31.51	60/32.73
II	73	7/17.85	7/16.37	9/15.40	7/15.40	7/12.04	7/10.92	8/9.72
		129	**283**	**283**	**325**	**239**	**255**	**258**

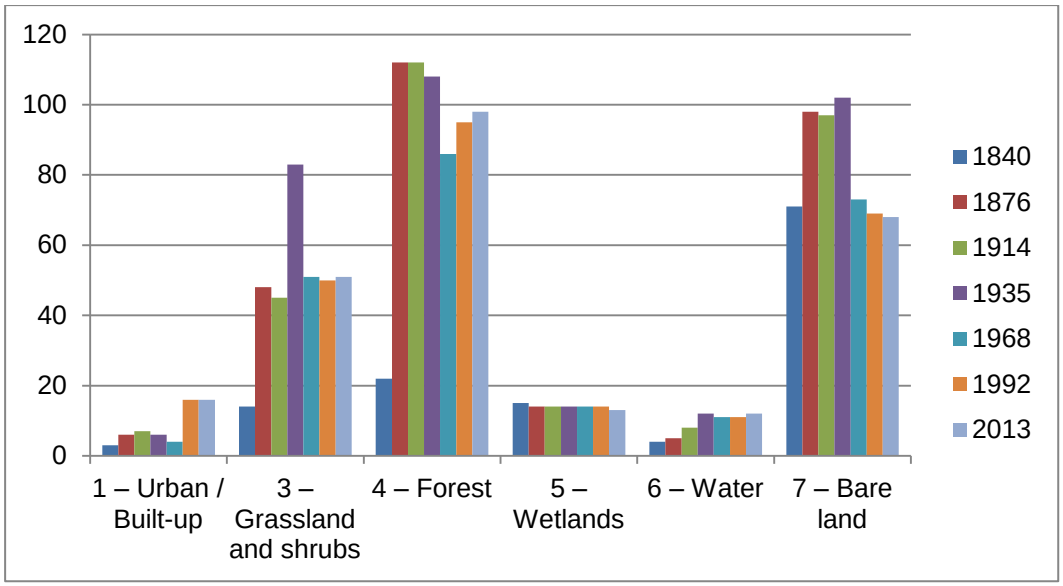


Figure 12. Number of areal features in I legend level land use / land cover category by years.

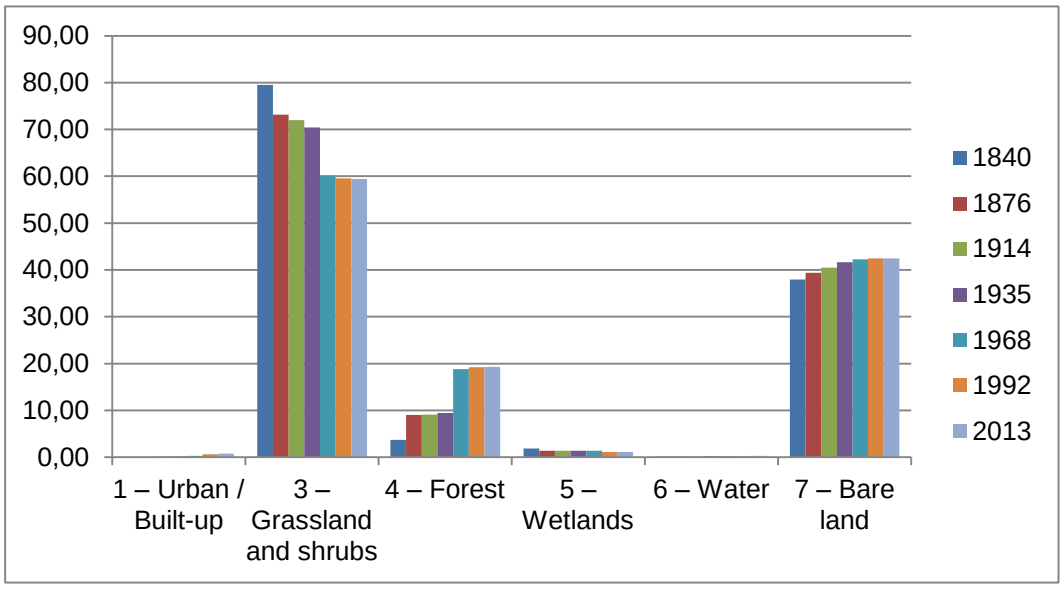


Figure 13. Area (km^2) of areal features in I legend level land use / land cover category by years.

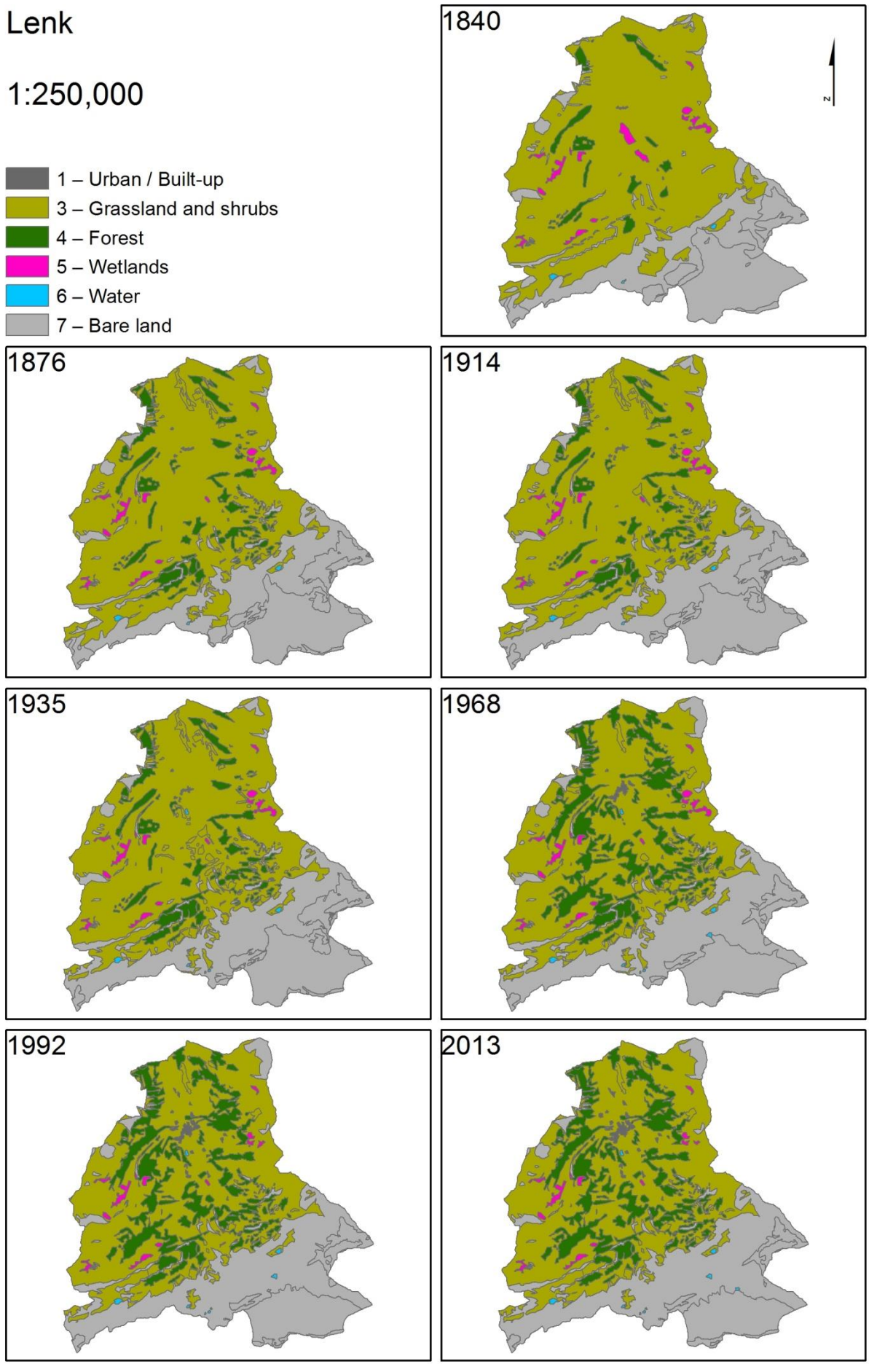

Lenk
1:250,000
1 – Urban / Built-up
3 – Grassland and shrubs
4 – Forest
5 – Wetlands
6 – Water
7 – Bare land
1840
N
1876
1914
1935
1968
1992
2013

Figure 14. Lenk land use / land cover change in I legend level by years. Grassland and shrubs are being replaced with forest mosaic. A large part is under bare land, including natural rock and glaciers. The glaciers area is shrinking each time period. Water bodies are related to bare land, wetlands with grassland and forest. Built-up area has had an increase (especially the scattered settlements that were not mapped) throughout the years but otherwise it seems to be a rather natural landscape with forest overgrowth.

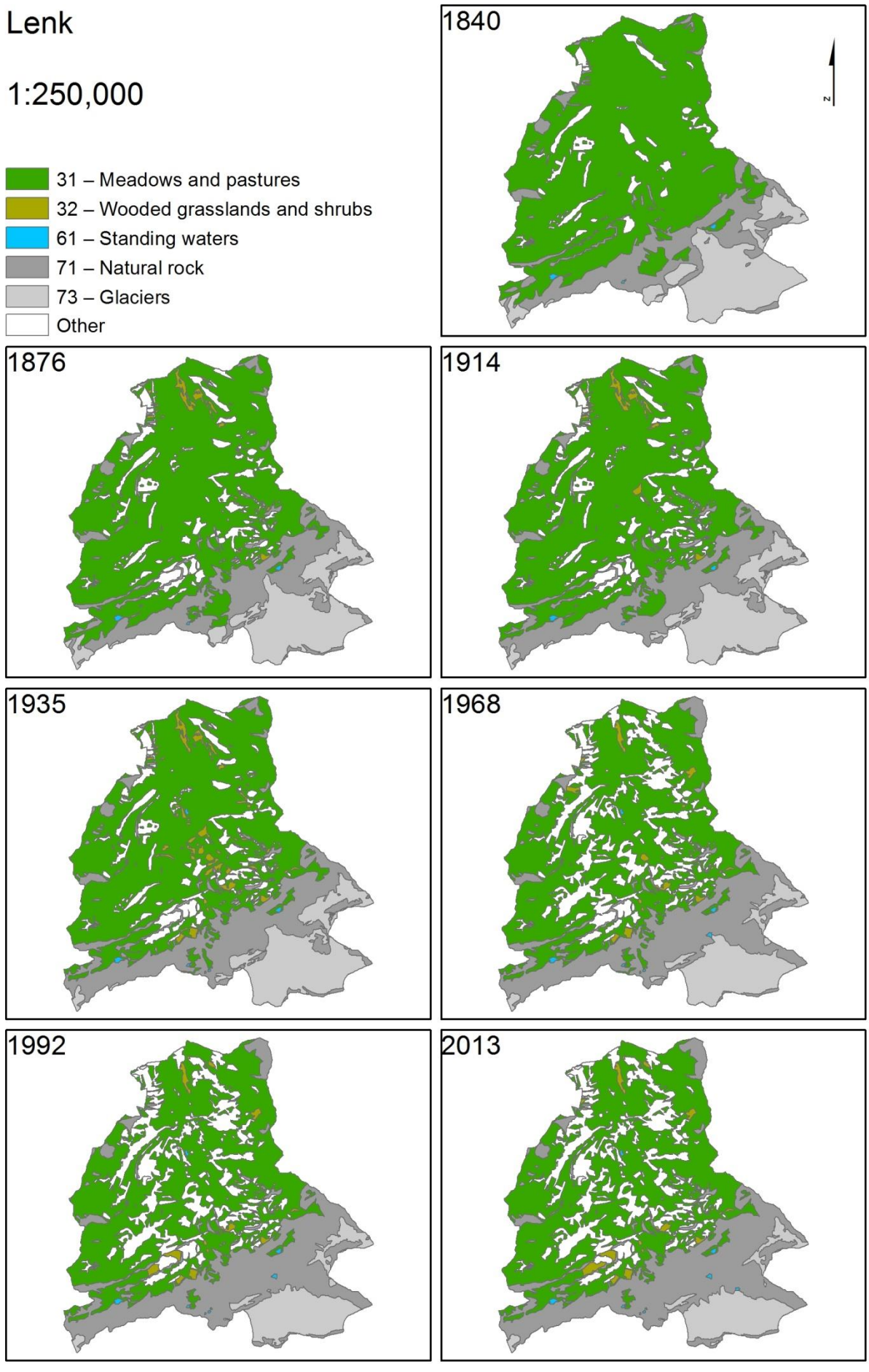

Lenk
1:250,000
31 – Meadows and pastures
32 – Wooded grasslands and shrubs
61 – Standing waters
71 – Natural rock
73 – Glaciers
Other
1840
N
1876
1914
1935
1968
1992
2013

Figure 15. Lenk land use / land cover change in II legend level by years.

Linear features

The composite legend of linear features for Lenk features cable car and pays more attention to road network than on water network (table 15).

Table 15. The composite legend of linear features for Lenk.

Legend level	I legend level category code and explanation	II legend level category code and explanation
I	1 – Water	
I	2 – Roads	
II		21 – Main roads
II		22 – Side roads
II		23 – Pathways
I	3 – Railways	
I	4 – Cable car	

The line density of (table 16 and figure 16):

1. the water network has remained the same, slightly increased,
2. the road network has grown, 1840 there was no main road, the network densed especially since 1968,
3. the rail network was established by 1914,
4. cable car was introduced 1968.

Table 16. The total number of linear features and their characteristics in every distinguished land use / land cover category by years.

Year	Legend level	Category	Features	Length (m)					Density (m/ha)
				Min	Max	Sum	Mean	SD[1]	
1840	**I**	**1**	**174**	**12**	**3790**	**127038**	**730**	**688**	**10.07**
	I	**2**	**113**	**3**	**4336**	**100419**	**889**	**956**	**7.96**
	II	22	12	3	2303	4783	399	631	0.38
	II	23	101	16	4336	95635	947	971	7.58
1876	**I**	**1**	**215**	**12**	**3790**	**146801**	**683**	**620**	**11.64**
	I	**2**	**194**	**3**	**4336**	**146825**	**757**	**783**	**11.64**
	II	21	6	112	3300	4076	679	1173	0.32
	II	22	17	6	2854	10975	646	812	0.87
	II	23	171	3	4336	131775	771	761	10.45
1914	**I**	**1**	**235**	**12**	**3790**	**149482**	**636**	**600**	**11.85**
	I	**2**	**190**	**5**	**4443**	**152076**	**800**	**813**	**12.06**
	II	21	6	112	3300	4076	679	1173	0.32
	II	22	16	6	3267	13317	832	1046	1.06
	II	23	168	5	4443	134684	802	770	10.68
	I	**3**	**5**	**11**	**1652**	**3374**	**675**	**660**	**0.27**
1935	**I**	**1**	**242**	**11**	**3790**	**152172**	**629**	**604**	**12.06**
	I	**2**	**274**	**3**	**3492**	**175989**	**642**	**691**	**13.95**
	II	21	6	112	3300	4076	679	1173	0.32
	II	22	38	3	3267	20571	541	826	1.63
	II	23	230	5	3492	151342	658	647	12.00

	I	**3**	**5**	**11**	**1652**	**3374**	**675**	**660**	**0.27**
1968	**I**	**1**	**391**	**7**	**3318**	**156577**	**400**	**400**	**12.00**
	I	**2**	**774**	**1**	**4320**	**293293**	**379**	**442**	**23.25**
	II	21	18	3	4276	9525	529	1084	0.76
	II	22	229	8	4320	81613	356	518	6.47
	II	23	527	1	2591	202155	384	360	16.03
	I	**3**	**4**	**195**	**1652**	**3364**	**841**	**638**	**0.27**
	I	**4**	**5**	**547**	**3198**	**8955**	**1791**	**853**	**0.71**
1992	**I**	**1**	**416**	**5**	**3316**	**163108**	**392**	**391**	**12.93**
	I	**2**	**827**	**3**	**5297**	**347840**	**421**	**499**	**27.57**
	II	21	39	3	4341	16530	424	885	1.31
	II	22	478	4	5297	189944	397	459	15.06
	II	23	310	4	3906	141366	456	489	11.21
	I	**3**	**4**	**195**	**1652**	**3364**	**841**	**638**	**0.27**
	I	**4**	**17**	**241**	**3198**	**18313**	**1077**	**703**	**1.45**
2013	**I**	**1**	**418**	**5**	**3110**	**165137**	**395**	**395**	**13.09**
	I	**2**	**890**	**3**	**5033**	**366376**	**412**	**482**	**29.04**
	II	21	47	3	4341	18558	395	773	1.47
	II	22	558	4	5033	208537	374	442	16.53
	II	23	285	6	3101	139280	489	485	11.04
	I	**3**	**4**	**195**	**1652**	**3364**	**841**	**638**	**0.27**
	I	**4**	**17**	**442**	**3511**	**21827**	**1284**	**886**	**1.73**

[1] SD – Standard deviation

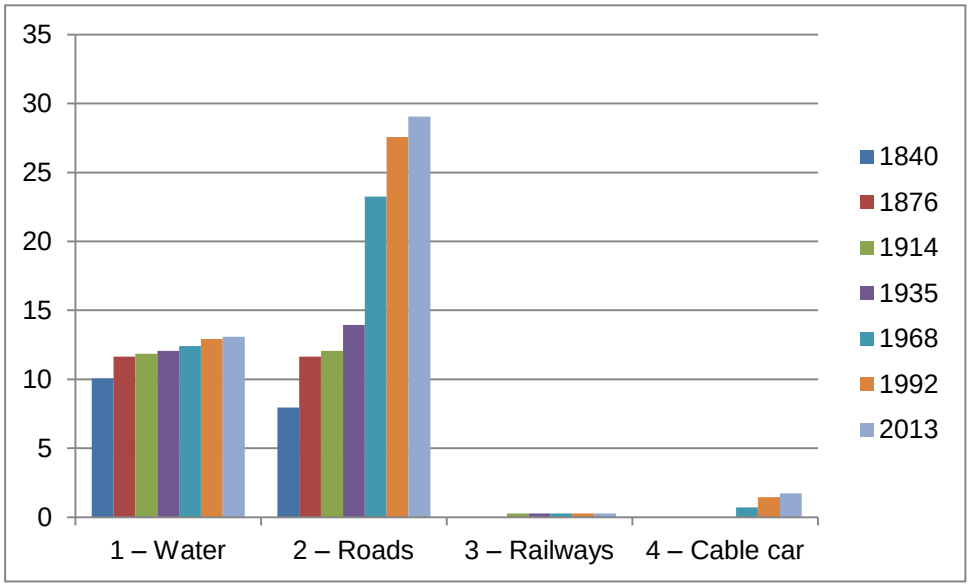


Figure 16. Density (m/ha) of linear features in I legend level land use / land cover category by years.

3.4 Spain – Sierra de Guadarrama foothills – Colmenar Viejo

Areal features

Spain has the most elaborate legend (table 17).

Table 17. The composite legend of areal features for Colmenar Viejo.

Legend level	I legend level category code and explanation	II legend level category code and explanation	III legend level category code and explanation
I	1 – Urban / Built-up		
I	2 – Agriculture		
II		21 – Seasonal agriculture	
III			212 – Vegetable gardens
II		22 – Perennial agriculture	
III			221 – Orchards
III			222 – Vineyards
III			224 – Olives
I	3 – Grassland and shrubs		
II		31 – Meadows and pastures	
III			311 – Meadows
III			312 – Pastures
II		32 – Wooded grasslands and shrubs	
II		33 – Dwarf pine	
I	4 – Forest		
II		43 – Evergreen forest	
I	7 – Bare land		
II		72 – Quarries	

The overall number of areal features has declined, yet in each LULC category there are some exceptions (table 18, figures 17–21).

1. Urban / built-up areas are growing in number and especially in area.
2. Agriculture has declined in plot numbers and area drastically by 1946, since 2000 a further shrinking can be observed.
3. Grassland and shrubs have increased both in numbers and area by 1946 and after that the number of plots has decreased, area has remained relatively similar.
4. Forest witnessed a drop in number and area by 1946 and has a small steady increase since.
5. Since 1988 quarries emerge.

Table 18. The total number and area (km^2) of areal features in every distinguished land use / land cover category by years.

Level	Category	Features / area (km^2)					
		1875	**1946**	**1971**	**1988**	**2000**	**2012**
I	**1**	**2/0.52**	**4/0.69**	**10/2.84**	**22/8.33**	**27/10.09**	**26/13.95**
I	**2**	**375/87.93**	**147/14.68**	**144/14.57**	**137/15.49**	**47/7.83**	**47/7.68**
II	21	344/84.36	145/14.64	142/14.53	130/15.13	39/7.66	39/7.53
III	212	3/0.11	3/0.11	0	0	0	0
II	22	31/3.57	2/0.04	2/0.04	7/0.36	8/0.17	8/0.16
III	221	1/0.00	1/0.00	1/0.00	4/0.27	7/0.10	7/0.09
III	222	30/3.57	1/0.04	1/0.04	2/0.02	0	0
III	224	0	0	0	1/0.07	1/0.07	1/0.07
I	**3**	**264/87.55**	**492/165.96**	**476/163.43**	**380/155.56**	**364/160.90**	**341/156.54**
II	31	0	383/121.16	323/98.51	206/74.50	194/80.42	173/74.79

III		311	0	160/43.12	104/20.65	27/8.26	29/9.74	20/9.23
III		312	0	222/78.01	218/77.83	179/66.24	165/70.67	153/65.57
II		32	262/87.28	101/43.19	124/57.67	140/71.99	134/70.01	134/71.27
II		33	2/0.27	8/1.61	29/7.26	34/9.07	36/10.47	34/10.48
I	**4**		**22/7.72**	**1/2.39**	**4/2.87**	**10/3.68**	**10/3.95**	**12/4.04**
II		43	22/7.72	1/2.39	4/2.87	10/3.68	10/3.95	12/4.04
I	**7**		**0**	**0**	**0**	**3/0.65**	**5/0.96**	**6/1.50**
II		72	0	0	0	3/0.65	5/0.96	6/1.50
			663	**644**	**634**	**552**	**453**	**432**

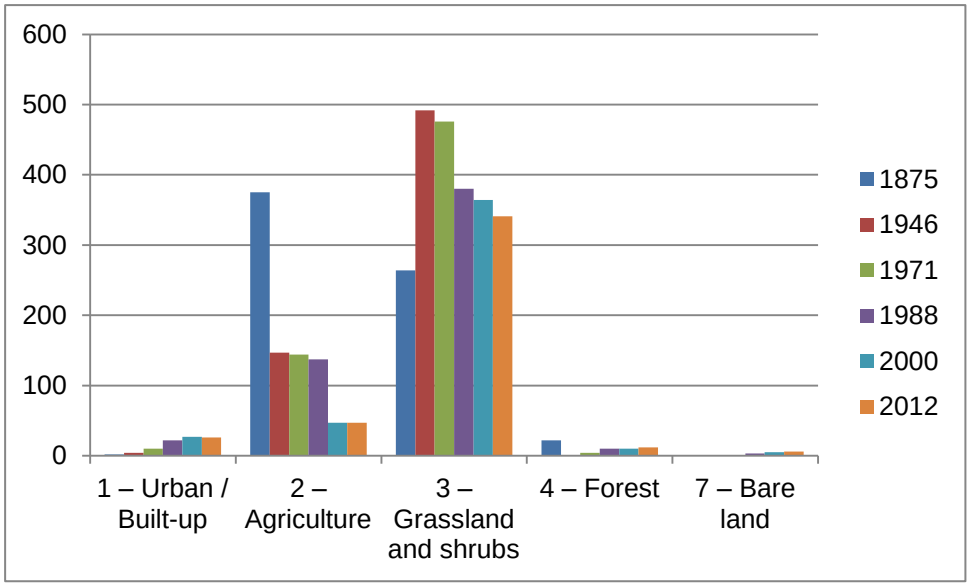


Figure 17. Number of areal features in I legend level land use / land cover category by years.

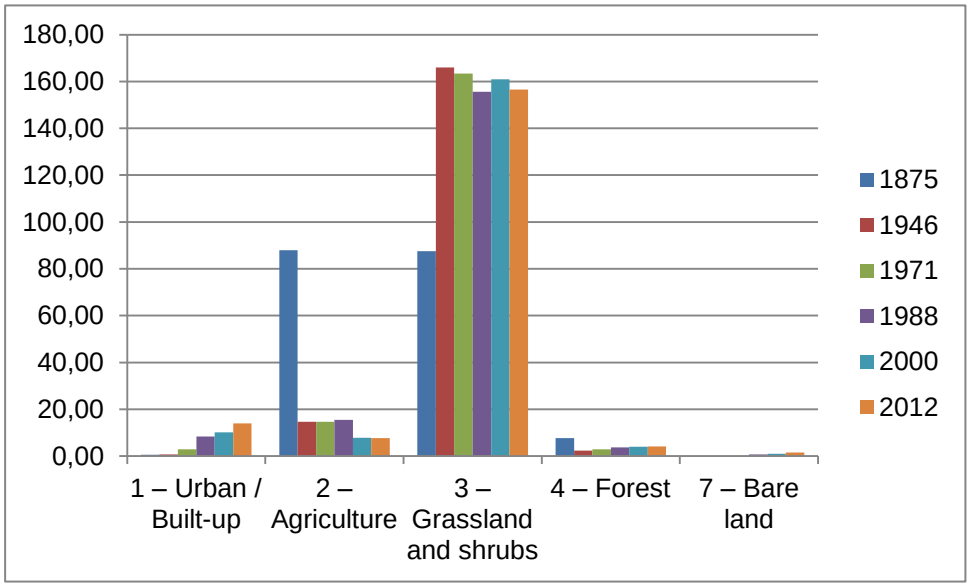


Figure 18. Area (km^2) of areal features in I legend level land use / land cover category by years.

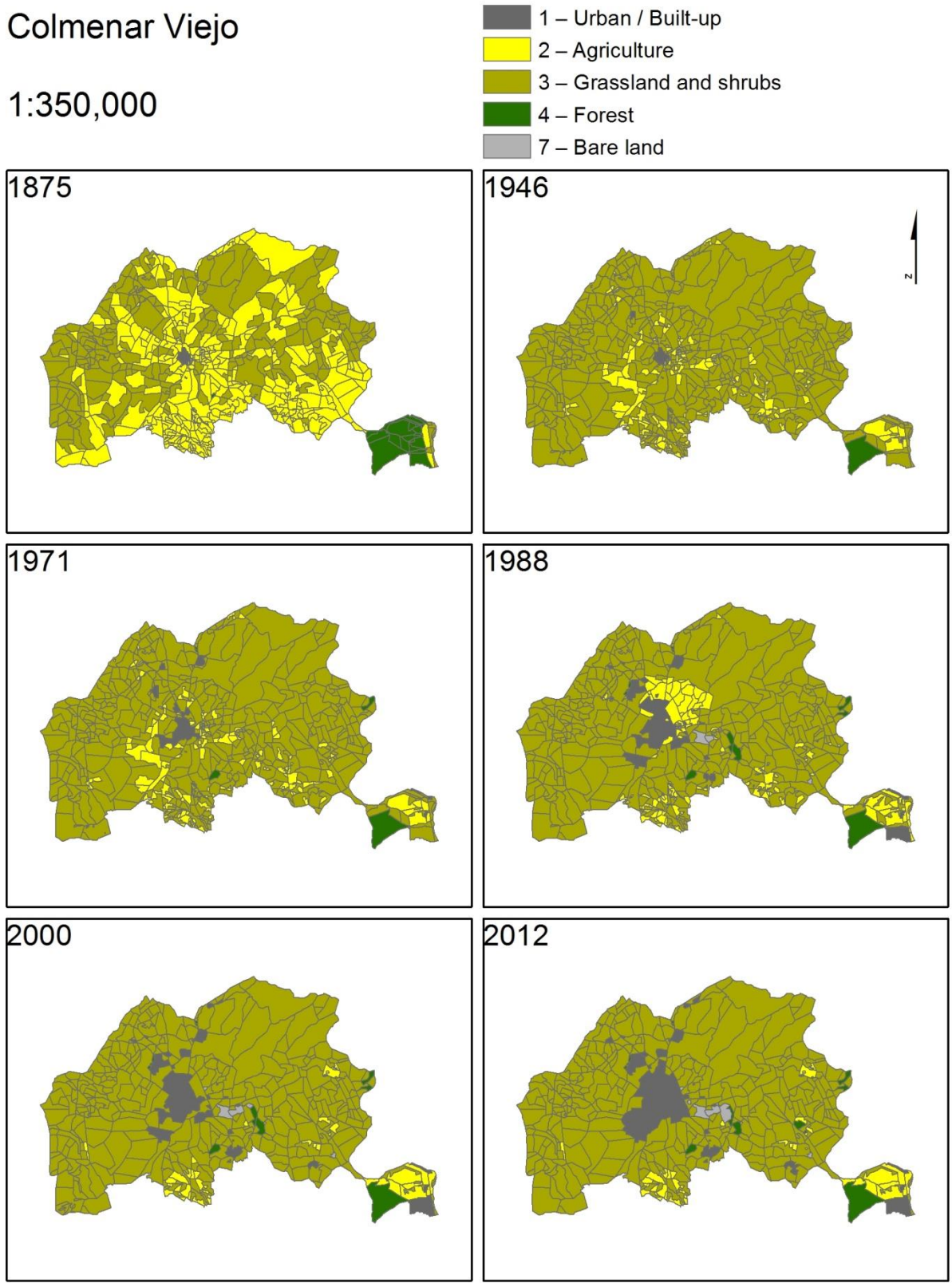


Figure 19. Colmenar Viejo land use / land cover change in I legend level by years. Agriculture vanishes by 1946, after that different areas have been used for production. The area of forest was half lost to agriculture. Built-up area spreads. Urban area with grasslands and shrubs dominate today.

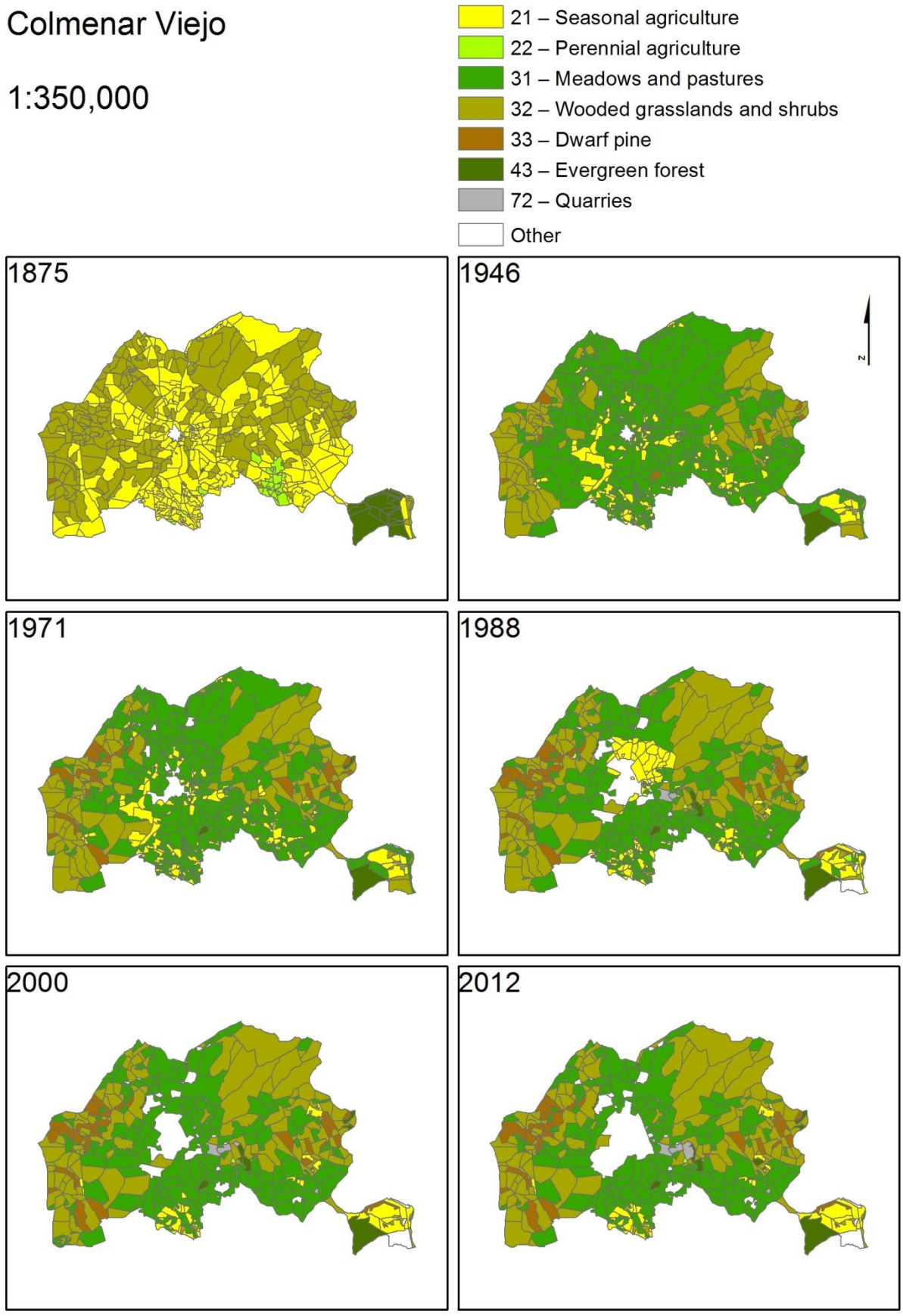


Figure 20. Colmenar Viejo land use / land cover change in II legend level by years.

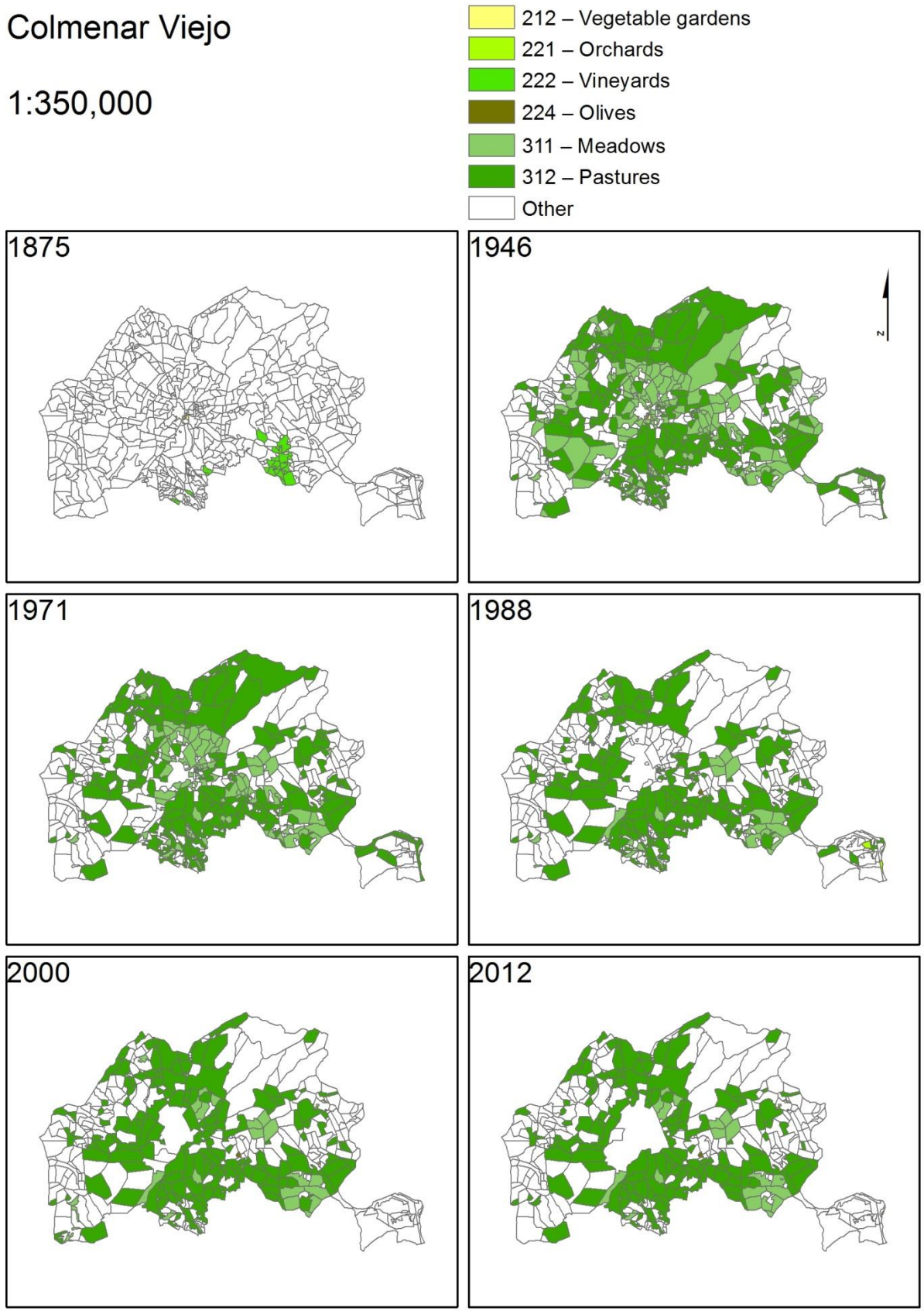


Figure 21. Colmenar Viejo land use / land cover change in III legend level by years.

Linear features

The composite legend of linear features for Colmenar Viejo is quite similar to other SMs with the exception of highways which appeared on the 1946 map and absence of pathways (table 19).

Table 19. The composite legend of linear features for Colmenar Viejo.

Legend level	I legend level category code and explanation	II legend level category code and explanation
I	1 – Water	
II		11 – Rivers
II		12 – Streams
II		13 – Channels
I	2 – Roads	
II		21 – Main roads
II		22 – Side roads
II		24 – Highways
I	3 – Railways	

The line density of (table 20 and figure 22):

5. the water networks has remained the same, slightly increased by 1971, when a new channel was mapped,
6. the road network has grown, the highway was discerned from 1946 map,
7. the rail network was established on 1946 map and a new line appeared on 2012 map.

Table 20. The total number of linear features and their characteristics in every distinguished land use / land cover category by years.

Year	Legend level	Category	Features	Length (m)					Density (m/ha)
				Min	Max	Sum	Mean	SD[1]	
1875	**I**	**1**	**69**	**300**	**15802**	**168312**	**2439**	**2670**	**9.20**
	II	11	1	15802	15802	15802	15802	0	0.86
	II	12	67	300	15411	145683	2174	2079	7.96
	II	13	1	6828	6828	6828	6828	0	0.37
	I	**2**	**85**	**216**	**13955**	**242890**	**2858**	**2428**	**13.27**
	II	21	3	1540	3585	7734	2578	835	0.42
	II	22	82	216	13955	235156	2868	2466	12.85
1946	**I**	**1**	**71**	**300**	**15802**	**170460**	**2401**	**2637**	**9.32**
	II	11	1	15802	15802	15802	15802	0	0.86
	II	12	69	300	15411	147831	2142	2050	8.08
	II	13	1	6828	6828	6828	6828	0	0.37
	I	**2**	**130**	**159**	**14650**	**307216**	**2363**	**2508**	**16.79**
	II	21	29	549	13707	80464	2775	3182	4.40
	II	22	94	159	14650	194808	2072	2088	10.65
	II	24	7	945	11173	31944	4563	3104	1.75
	I	**3**	**1**	**15882**	**15882**	**15882**	**15882**	**0**	**0.87**
1971	**I**	**1**	**72**	**300**	**15802**	**180684**	**2510**	**2774**	**9.87**
	II	11	1	15802	15802	15802	15802	0	0.86
	II	12	69	300	15411	147831	2142	2050	8.08
	II	13	2	6828	10224	17052	8526	1698	0.93

	I	**2**	**146**	**159**	**14650**	**325553**	**2230**	**2411**	**17.79**
	II	21	31	549	13707	84463	2725	3097	4.62
	II	22	108	159	14650	208491	1930	1988	11.39
	II	24	7	945	11173	32600	4657	3063	1.78
	I	**3**	**1**	**15882**	**15882**	**15882**	**15882**	**0**	**0.87**
1988	**I**	**1**	**72**	**300**	**15802**	**180684**	**2510**	**2774**	**9.87**
	II	11	1	15802	15802	15802	15802	0	0.86
	II	12	69	300	15411	147831	2142	2050	8.08
	II	13	2	6828	10224	17052	8526	1698	0.93
	I	**2**	**155**	**159**	**14078**	**350584**	**2262**	**2349**	**19.16**
	II	21	29	549	13707	82347	2840	3155	4.50
	II	22	118	159	14078	229064	1941	1904	12.52
	II	24	8	945	10220	39174	4897	2783	2.14
	I	**3**	**1**	**15882**	**15882**	**15882**	**15882**	**0**	**0.87**
2000	**I**	**1**	**72**	**300**	**15802**	**180684**	**2510**	**2774**	**9.87**
	II	11	1	15802	15802	15802	15802	0	0.86
	II	12	69	300	15411	147831	2142	2050	8.08
	II	13	2	6828	10224	17052	8526	1698	0.93
	I	**2**	**125**	**216**	**14078**	**314292**	**2514**	**2474**	**17.18**
	II	21	29	549	13707	80680	2782	3191	4.41
	II	22	87	216	14078	192992	2218	2011	10.55
	II	24	9	1064	10220	40621	4513	2837	2.22
	I	**3**	**1**	**15882**	**15882**	**15882**	**15882**	**0**	**0.87**
2012	**I**	**1**	**72**	**300**	**15802**	**180684**	**2510**	**2774**	**9.87**
	II	11	1	15802	15802	15802	15802	0	0.86
	II	12	69	300	15411	147831	2142	2050	8.08
	II	13	2	6828	10224	17052	8526	1698	0.93
	I	**2**	**124**	**216**	**14078**	**313820**	**2531**	**2479**	**17.15**
	II	21	36	549	13707	115004	3195	3098	6.29
	II	22	79	216	14078	158190	2002	1850	8.65
	II	24	9	1064	10220	40626	4514	2838	2.22
	I	**3**	**2**	**2967**	**15882**	**18849**	**9424**	**6458**	**1.03**

[1] SD – Standard deviation

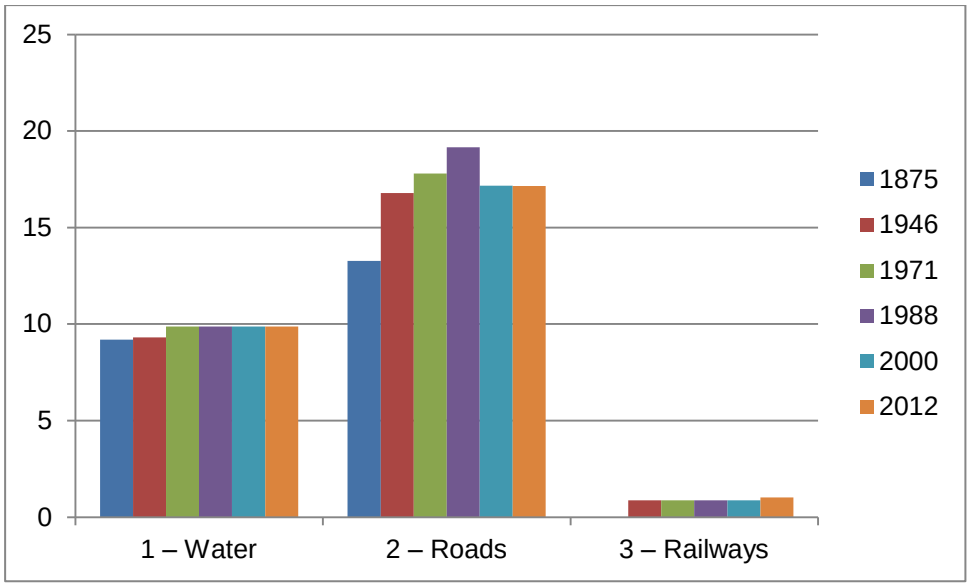


Figure 22. Density (m/ha) of linear features in I legend level land use / land cover category by years.

3.5 Sweden – Uppland – Börje

Areal features

For Sweden, which is known for its good historical maps, only five I legend level categories could be distinguished for areal features (table 21).

Table 21. The composite legend of areal features for Börje.

Legend level	I legend level category code and explanation
I	1 – Urban / Built-up
I	2 – Agriculture
I	3 – Grassland and shrubs
I	4 – Forest
I	6 – Water

The overall number of areal features is slowly declining yet in each LULC category there are some exceptions (tables 22 and 23, figures 23, 24 and 25).

1. Urban / built-up areas are growing in number and areas.
2. Agriculture is declining in plot numbers but the area has increased a little and then turned again to small decline.
3. Grassland and shrubs have a very small increased in number but their total area shows concave tendency.
4. Forest patches show a decline yet their area has not decreased so much.
5. Water from Börje sjö has dried out and is replaced by forest in the middle of 20th century.

Table 22. The total number and area (km^2) of areal features in every distinguished land use / land cover category by years.

		Features / area (km^2)				
Year	**Features**	**1 – Urban / Built-up**	**2 – Agriculture**	**3 – Grassland and shrubs**	**4 – Forest**	**6 – Water**
1861	**632**	79/1.12	203/14.25	97/6.26	246/24.90	7/0.07
1945	**632**	115/1.70	204/18.74	105/2.02	202/24.13	6/0.03
1977	**602**	159/2.22	163/18.27	92/1.90	182/24.20	6/0.03
2013	**498**	179/2.68	64/15.42	110/4.52	139/23.97	6/0.03

As the number of years and legend level allows, the whole table of the kind of information available for all SMs is inserted here (table 24).

Table 23. The total number of areal features and their characteristics in every distinguished land use / land cover category by years.

				Area					Perimeter				
Year	**Legend level**	**Category**	**Features**	**Min**	**Max**	**Sum**	**Mean**	**SD**	**Min**	**Max**	**Sum**	**Mean**	**SD**
1861	I	1	79	624	68083	1124918	14239	13274	113	1166	38644	489	255
	I	2	203	1	1221597	14253405	70214	154831	5	15371	267596	1318	1890
	I	3	97	778	610358	6264425	64582	114946	124	7829	127877	1318	1235
	I	4	246	32	2949746	24904132	101236	296967	53	14020	311189	1265	1690
	I	6	7	2374	45609	73166	10452	14496	205	1065	2856	408	287
1945	I	1	115	624	81227	1699022	14774	14027	113	1554	57897	503	264
	I	2	204	1	1516095	18743449	91880	217631	5	16092	298192	1462	2040
	I	3	105	594	111804	2021595	19253	20501	141	3789	86780	826	735
	I	4	202	32	2763183	24128443	119448	274921	53	12111	269928	1336	1611
	I	6	6	2374	8215	27557	4593	2199	205	521	1791	298	109
1977	I	1	159	5	91915	2220501	13965	13546	13	1430	78974	497	265
	I	2	163	1	1516095	18274464	112113	241084	5	16092	277699	1704	2257
	I	3	92	13	111315	1897097	20621	22093	17	3789	80691	877	786
	I	4	182	32	2768877	24200446	132969	289287	53	12126	261592	1437	1665
	I	6	6	2374	8215	27557	4593	2199	205	521	1791	298	109
2013	I	1	179	2	91915	2681176	14979	15857	57	1765	92427	516	311
	I	2	64	1	1516095	15420583	240947	346703	5	16092	193115	3017	3025
	I	3	110	594	284005	4520057	41091	50025	141	5165	132898	1208	1000
	I	4	139	32	2302492	23970693	172451	296454	53	10892	249185	1793	1721
	I	6	6	2374	8215	27557	4593	2199	205	521	1791	298	109

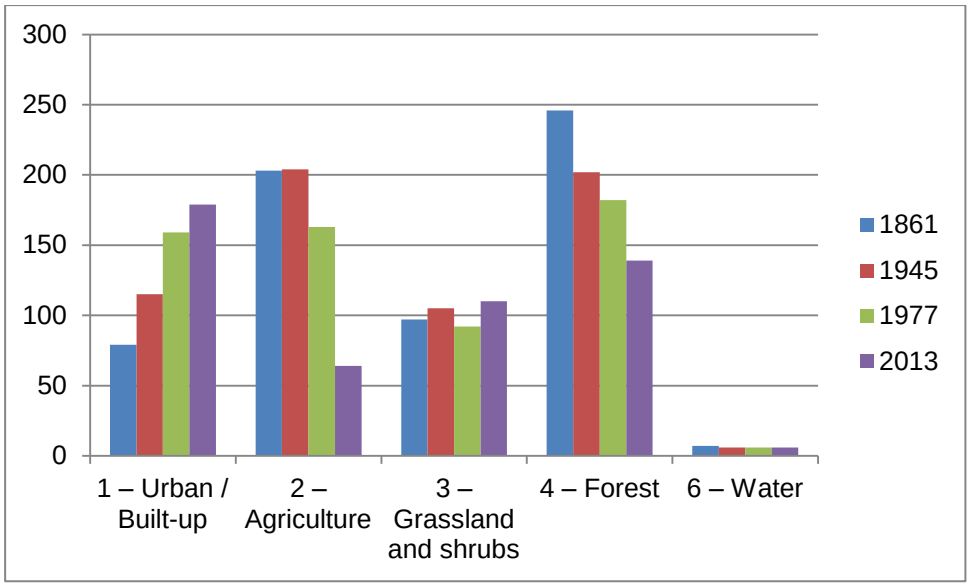


Figure 23. Number of areal features in I legend level land use / land cover category by years.

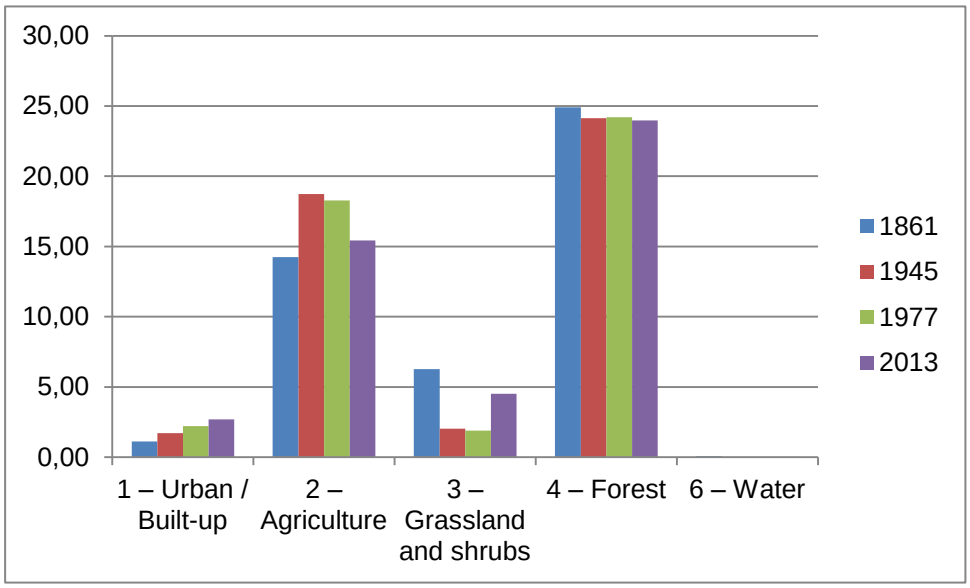


Figure 24. Area (km^2) of areal features in I legend level land use / land cover category by years.

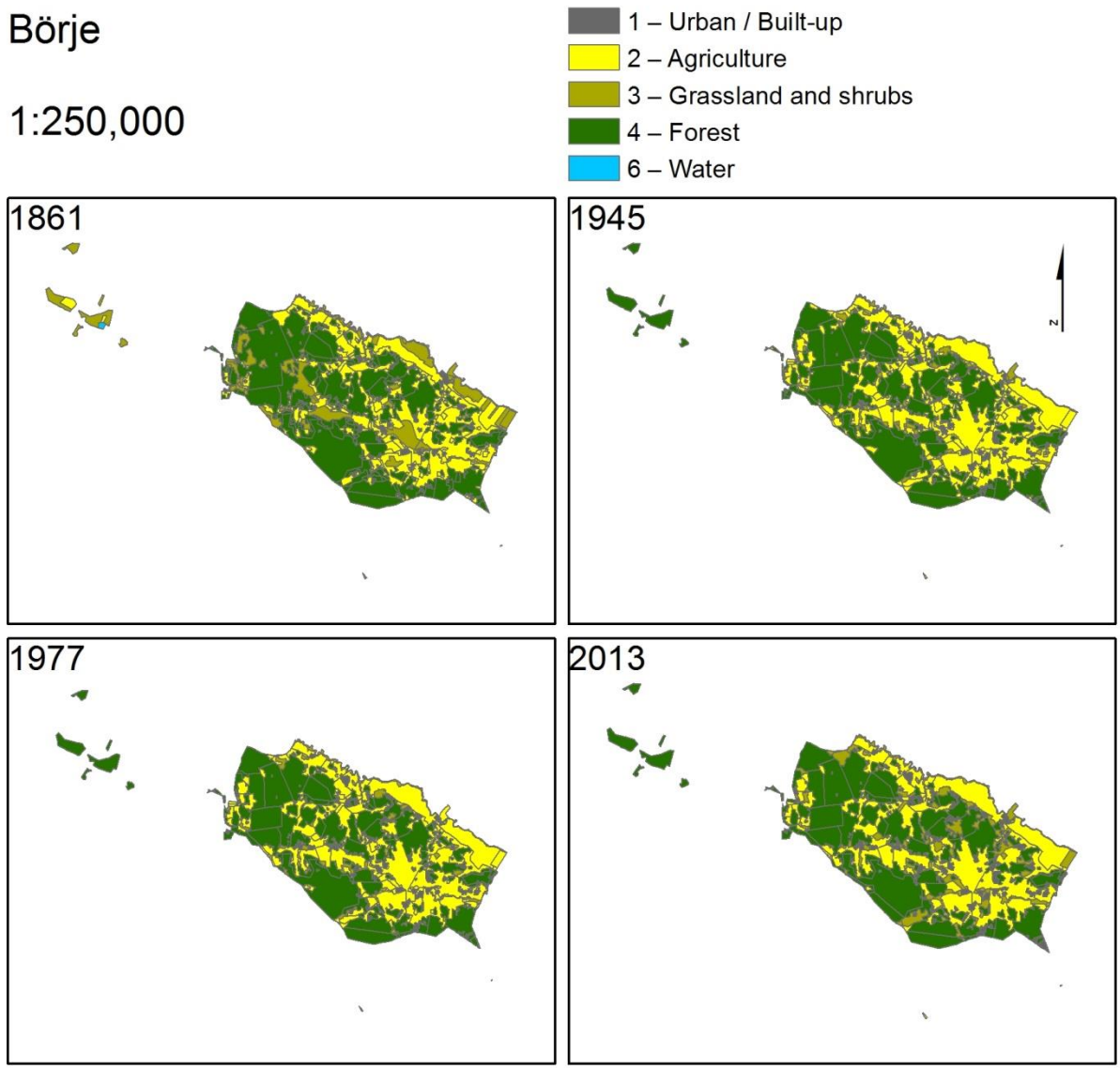


Figure 25. Börje land use / land cover change in I legend level by years. No big change has happened in the shares of agriculture and forest. Built-up areas are slowly increasing preserving the scattered mosaic appearance. When 1861 grasslands and shrubs formed quite a share in landscape, their area diminished during the 20th century and sees a small rise in 21st, perhaps as urban way of life creeps into countryside leaving fields aside or more eco-aware attitudes have emerged.

Linear features

The composite legend of linear features for Börje is quite similar to other SMs (table 24).

Table 24. The composite legend of linear features for Börje.

Legend level	I legend level category code and explanation	II legend level category code and explanation
I	1 – Water	
II		11 – Rivers
II		12 – Streams
II		13 – Channels
I	2 – Roads	
II		21 – Main roads

	II	22 – Side roads
	II	23 – Pathways
I	3 – Railways	

The line density of (table 25 and figure 20):

1. the water networks has remained the same,
2. the road network has grown,
3. the rail network was established on 1945 map.

Table 25. The total number of linear features and their characteristics in every distinguished land use / land cover category by years.

Year	Legend level	Category	Features	Length (m)					Density (m/ha)
				Min	Max	Sum	Mean	SD[1]	
1861	**I**	**1**	**82**	**33**	**7366**	**60576**	**739**	**993**	**12.99**
	II	11	1	1569	1569	1569	1569	0	0.34
	II	12	8	205	7366	15694	1962	2282	3.37
	II	13	73	33	3209	43313	593	585	9.29
	I	**2**	**56**	**19**	**4835**	**72490**	**1294**	**1191**	**15.55**
	II	21	6	149	4511	16575	2762	1478	3.56
	II	22	28	19	4835	37817	1351	1166	8.11
	II	23	22	39	2473	18098	823	687	3.88
1945	**I**	**1**	**82**	**33**	**7366**	**60576**	**739**	**993**	**12.99**
	II	11	1	1569	1569	1569	1569	0	0.34
	II	12	8	205	7366	15694	1962	2282	3.37
	II	13	73	33	3209	43313	593	585	9.29
	I	**2**	**194**	**6**	**9176**	**97715**	**504**	**875**	**20.96**
	II	21	8	149	9176	23449	2931	2865	5.03
	II	22	120	11	3819	42536	354	446	9.12
	II	23	66	6	1555	31731	481	370	6.81
	I	**3**	**1**	**5507**	**5507**	**5507**	**5507**	**0**	**1.18**
1977	**I**	**1**	**82**	**33**	**7366**	**60576**	**739**	**993**	**12.99**
	II	11	1	1569	1569	1569	1569	0	0.34
	II	12	8	205	7366	15694	1962	2282	3.37
	II	13	73	33	3209	43313	593	585	9.29
	I	**2**	**192**	**6**	**9312**	**96294**	**502**	**896**	**20.66**
	II	21	7	129	9312	23572	3367	2940	5.06
	II	22	113	12	3819	43401	384	496	9.31
	II	23	72	6	1555	29321	407	293	6.29
	I	**3**	**1**	**5507**	**5507**	**5507**	**5507**	**0**	**1.18**
2013	**I**	**1**	**82**	**33**	**7366**	**60576**	**739**	**993**	**12.99**
	II	11	1	1569	1569	1569	1569	0	0.34
	II	12	8	205	7366	15694	1962	2282	3.37
	II	13	73	33	3209	43313	593	585	9.29
	I	**2**	**256**	**6**	**9312**	**120020**	**469**	**826**	**25.74**
	II	21	7	149	9312	23691	3384	2922	5.08
	II	22	170	12	3819	65072	383	519	13.96
	II	23	79	6	1646	31257	396	319	6.70
	I	**3**	**1**	**5507**	**5507**	**5507**	**5507**	**0**	**1.18**

[1] Standard deviation

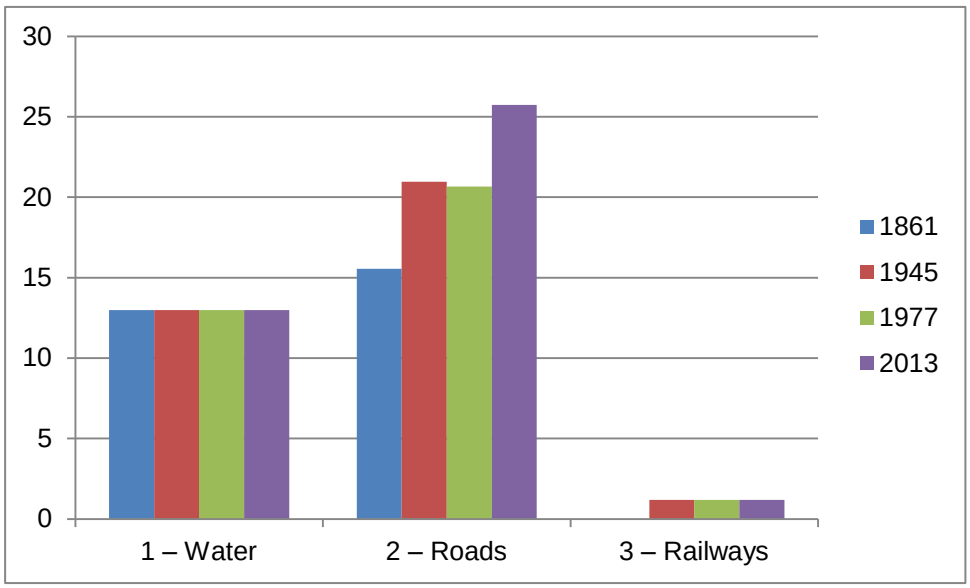


Figure 20. Density (m/ha) of linear features in I legend level land use / land cover category by years.

4 Conclusion

As the variety of available maps, scales and level of detail for each Study Municipality (SM) in different natural, physical, political, social and cultural environments is enormous, it does not justify cross-SM comparisons on land use / land cover (LULC) change analysis level. Still, some individual conclusions for Compiled timelines of cultural landscape change (CTCLC) for specific SM can be drawn:

1. Estonia: Study Landscape (SL) – Vooremaa and Kodavere, Study Municipality (SM) – Alatskivi and Peipsiääre. The areal legend has three levels (15 categories) and linear legend two levels (8 categories). The most remarkable change has been the drying up of wetlands and overgrowth of forest as this SM and SL is marginalised. Palang et al. 1998 have shown that dramatic landscape change does occur congruently with polity changes, yet it evens out over larger territories. The convex trends of built-up area, agriculture and grassland and shrubs of the long 20th century seem realistic, although the processes of gaining more agricultural land and forsaking poorer soils should flat out the differences. Otherwise the landscape has been quite stable: massive forest with mosaic village landscapes. Constant amelioration landscape in the marginalised region. Interesting would be the further comparison of the two municipalities – Alatskivi and Peipsiääre – as the latter is perceived as conglomeration of more of the Russian Old Believers villages of the shore of Lake Peipsi.
2. Greece: SL – Lesvos, SM – Gera. Despite the scarcity of available maps – 1960 and 2012 – the areal legend has three levels (12 categories) and linear legend two levels (5 categories). The most remarkable change has been the decline of agriculture whereas the grassland and shrubs, especially wooded grasslands and shrubs taking over. Also the forest and built-up areas are increasing as is the road network. Probably the processes of modernisation and tourist influx have had the impact on abandoning agriculture, which in turn may negatively affect tourism industry that is in search for traditional olive landscapes.
3. Switzerland: SL – Obersimmental, SM – Lenk. The best time coverage of seven maps since 1840, on areal legend on two levels (11 categories) and on linear legend two levels (7 categories). The most remarkable factors are missing agriculture and presence of bare land in the form of natural rock and glaciers. The most obvious change has been the decrease and fragmentation of grassland and shrubs replaced by forest mosaic. Small opposing trends are for wetlands by grassland and forest and water bodies by bare land, the former is decreasing and the latter is increasing. Bare land is slowly growing by area but the area of glaciers is melting away. Infrastructure has been modernised by main roads, railway by 1914 and cable car by 1968. Built-up area shows small increasing trend, especially for number since 1992. It seems to be a rather natural landscape with forest overgrowth if this is not planted.
4. Spain: SL – Sierra de Guadarrama foothills, SM – Colmenar Viejo. Finely tuned areal legend on three levels (18 categories), linear on two levels (9 categories) across six mapping years. The overall number of patches seems to be in small decline – is it only a mapping peculiarity (which maps are more detailed, the 19th century ones or orthophotos?) or homogenisation? 1946 seems to be the crucial year, although previous map was 71 years younger, from 1875 and the next map 25 years later, from

1971. By that year agriculture was in large amounts substituted with grasslands and shrubs. The land for agricultural production has "moved around" the urban area. A more detailed analysis into agricultural sub-fields (vegetable gardens, orchards, vineyards, olives) may shed some light here. Additional drop in agricultural lands emerged since 2000. For forest also 1946 seem to be almost clear cut year, ever since its area is very slowly growing. Built-up area spreads as it is situated NW from Madrid. Since 1988 quarries emerge in the eastern side as the western part of the municipality is a regional park. Urban area with grasslands and shrubs dominate today. On 1946 highway and railway appeared on the map, in 1971 a new channel, by 2012 additional rail road was placed. A peri-urban landscape that is in constant change.

5. Sweden: SL – Uppland, SM – Börje. Only four maps were attainable for this project and areal legend had only one level (5 categories) and linear level had two levels (9 categories). The overall number of patches seems to be in small decline – is it only a mapping peculiarity (which maps are more detailed, the 19th century ones or orthophotos?) or homogenisation? Similarly to Spain situation the gap between first (1861) and second map (1945) is 84 years, yet the changes are not radical at all. Built-up areas demonstrate a small steady growth preserving probably scattered mosaic land use. By comparing the number of plots and area for agriculture it seems that more monolithic fields appear. When 1861 grasslands and shrubs formed quite a share in landscape, their area diminished during the 20th century and sees a small rise in 21st, perhaps as urban way of life creeps into countryside leaving fields aside or more eco-aware attitudes have emerged. Similarly to agriculture, forest seems to be gaining bigger plots for the same area. Road network has got denser and railway appeared on 1945 map. No big change has happened in the shares of agriculture and forest so its seems that Börje parish, regardless of the vicinity of Uppsala, lives its own life in peri-urban equilibrium, if this is a possibility.

The mapping exercise results will be uploaded to Knowledge Hub (KH).

The outcome of CTCLC based on LULC change analysis will serve as a basis for "objective" background against which comparison of other methods, e.g. oral history interviews (OHI), major events and driving forces (DF) analysis, public participatory GIS (PP-GIS), terrestrial photos, 3D diagrams etc. can be done forming Landscape change trajectories (LCT) (compare to path dependency in landscapes, e.g. Zariņa 2013) as case study approach, eventually leading to tasks three and four (Assessment of driving forces and actors and Comparative analyses, respectively).

The overall outcome should be enhanced understanding of *perceived* landscape change and improving comparative methods for achieving that.

References

Anderson, J. 2004: Talking whilst walking: a geographical archaeology of knowledge. *Area* 36 (3): 254–261.

Arístegui Cortijo, A. 2013: *La cartografía histórica del Instituto Geográfico Nacional, fuente para el estudio de núcleos urbanos: el caso de Colmenar Viejo (Madrid)*. Instituto Geográfico nacional http://www.ign.es/ign/resources/actividades/sdg/articulo_cartohistorica_colmenarviejo.pdf.

Departamento Interuniversitario de Ecología de Madrid, and Universidad Autónoma de Madrid 1991: La Dehesa del Colmenar. Ayuntamiento del Colmenar Viejo.

Harley, J.B. 1989: Deconstructing the map. *Cartographica* 26 (2): 1–20.

Helmfrid, S. 1961: The storskifte, enskifte and laga skifte in Sweden: general features. *Geografiska Annaler* 43 (1/2) Morphogenesis of the Agrarian Cultural Landscape: Papers of the Vadstena Symposium at the XIXth International Geographical Congress, pp. 114–129.

Käyhkö, N. and H. Skånes 2006: Change trajectories and key biotopes: assessing landscape dynamics and sustainability. *Landscape and Urban Planning* 75 (3–4): 300–321.

Käyhkö, N. and H. Skånes 2008: Retrospective land cover/land use change trajectories as drivers behind the local distribution and abundance patterns of oaks in south-western Finland. *Landscape and Urban Planning* 88: 12–22.

Monmonier, M. 1991: *How to Lie with Maps*. Chicago: University of Chicago Press.

Palang, H., Ü. Mander and A. Luud 1998: Landscape diversity changes in Estonia. *Landscape and Urban Planning* 41 (3–4): 163–169.

Peterson, U. and R. Aunap 1998: Changes in agricultural land use in Estonia in the 1990s detected with multitemporal Landsat MSS imagery. *Landscape and Urban Planning* 41 (3): 193–201.

Sabau Bergamin, G. 2002: *Historia de San Lorenzo de El Escorial*. San Lorenzo de El Escorial (Madrid): Comunidad de Madrid, Ayuntamiento de San Lorenzo de El Escorial y Ediciones Doce calles.

Zariņa, A. 2013: Path dependence and landscape: initial conditions, contingency and sequences of events in Latgale, Latvia. *Geografiska Annaler: Series B Human Geography* 95 (4): 355–373.

Annexes

Annex 1: Spatial data availability for Study Landscapes (SL) in WP3 Landscape-scale case studies (short-term history)

For the purposes of WP 3 Landscape-scale case studies (short-term history) we want to focus on one representative **Study Municipality** (SM) (or community) within the larger study landscape (SL). The reason for narrowing down the area is to ascertain the feasibility of analysis that we have planned. The European NUTS (Nomenclature of Territorial Units for Statistics) regulation defines minimum and maximum population thresholds for the size of the NUTS regions; for the smallest NUTS 3 it is 150,000–800,000 inhabitants, which for e.g. Estonian case would mean half of the country's territory – for short-term landscape history it is not feasible scale. What we would like you to consider is whether NUTS 3 is good scale in your country or perhaps LAU (Local Administrative Units) 1 and LAU 2 (formerly NUTS 4 and 5) could apply for the selection of concrete municipality for comparative and also for community study integrity reasons in questionnaires and interviews which will accompany the cartographic analysis. The approach for using current administrative borders (vs. map sheets or transects etc.) was achieved after some discussions taking into account previous experiences dealing with landscape history.

For checking the availability of detail spatial data to safeguard that our planned analyses could be carried out we need the information in this questionnaire by **30.04.2014 (Month 5)** sent to **Anu Printsmann (anu.printsmann@tlu.ee)**. We will then decide on which data we would like to work with and inform you about this by 31.05.2014 (M6). As described in the Workplan, we face some organisational challenges for the land use / land cover (LULC) analysis (T 3.2). We hope that some SM can provide their data rather fast (e.g. maps easily available etc.). The data collected will have to be sent to Anu Printsmann (Dropbox or FTP etc. will be fine) either by 31.07.2014 (M8 – fast-track SM) or 30.09.2014 (M10 – slow-track SM).

Contact person

Name of the contact person:

E-mail of the contact person:

Organisation of the contact person:

Study Landscape (SL) and Study Municipality (SM)

Country:

Name of Study Landscape (SL):

Abbreviation (3 letter acronym) for the SL:

Study Municipality (SM) within SL pertaining directly WP 3:

Fast-track SM or slow-track SM:

Have the administrative borders of this SM been changed since 1800 AD, please describe:

Maps

Since 1800 how many maps are available on the whole of the SM, with scale approximately 1:10,000–1:50,000:

For each of these maps, please provide:

1. year of mapping / publishing:
2. scale of mapping:
3. purpose of mapping or map name:
4. map legend (land cover classes, linear elements, point data depicted) (if possible, please send sample image of the legend):
5. are property boundaries / ownership mapped:
6. format of the map (analogue, digital, web, scan, rectified scan, vectorised – in which software):
7. is there WMS (Web Map Service/Server) possibility and limitations for using that:
8. how easy / costly it is for you to get the map:
9. are there any legal issues involved, e.g. for publishing it on web etc.:
10. if possible, please send sample image of the map.

Cadastral maps – sometimes these are located in municipalities

When was the first cadastral map composed:

How many cadastral maps do you have since 1800:

For each of these maps, please provide:

1. year of mapping / publishing:
2. scale of mapping:
3. map name:
4. map legend (land cover classes, linear elements, point data depicted) (if possible, please send sample image of the legend):
5. are property boundaries / ownership mapped:
6. format of the map (analogue, digital, web, scan, rectified scan, vectorised – in which software):
7. is there WMS (Web Map Service/Server) possibility and limitations for using that:
8. how easy / costly it is for you to get the map:
9. are there any legal issues involved, e.g. for publishing it on web etc.:
10. if possible, please send sample image of the map.

Aerial / ortophotos / satellite imagery

For each aerial / ortophoto / satellite imagery, please provide:

1. year of mapping / publishing:
2. scale / flight height/altitude:
3. resolution (pixel size):
4. name:
5. format of the map (analogue, digital, web, scan, rectified scan, vectorised – in which software):
6. is there WMS (Web Map Service/Server) possibility and limitations for using that:
7. how easy / costly it is for you to get the map:
8. are there any legal issues involved, e.g. for publishing it on web etc.:
9. if possible, please send sample image of the map.

Terrestrial photos / landscape photos / postcards

Do you have historical photographs? From which years? In what format? Costs involved? Legal issues? If possible, please send sample images.

Have you any repeat photography from the SM? Do you have the capacity to conduct re-photography on some pictures selected?

Additional information

Are there any other interesting maps since 1800 (e.g. Spain is using vegetation maps although the scale is 1:100,000, Estonia has 1:10,000 soil map)?

Is there any other, auxiliary information on property boundaries / ownership?

Are there monographs or articles on the history of the SM?

Are local experts on the history of the SM available?

Are there local archives?

Do you have LIDAR data or already ready-made DEM (Digital Elevation Model), DTM (Digital Terrain Model) and DSM (Digital Surface Model)?

Can you please describe the situation whether available map information concerning land use intensity could be gained.

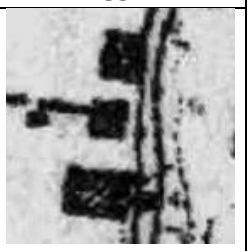
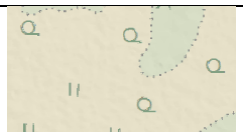
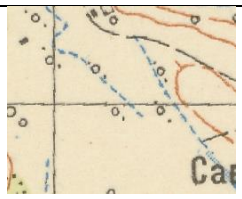
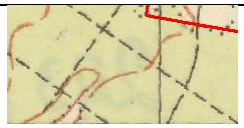
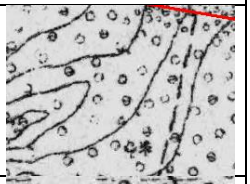
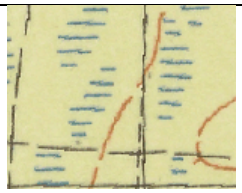
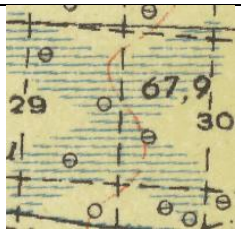
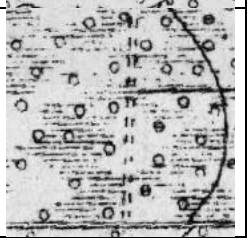
Are there some statistical data available on:

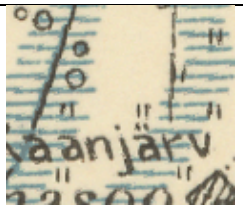
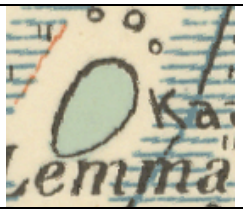
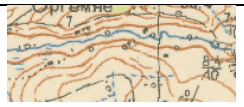
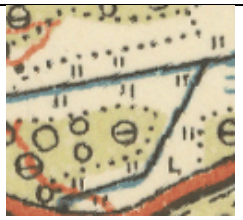
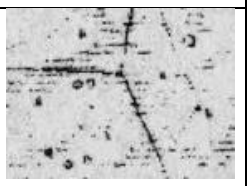
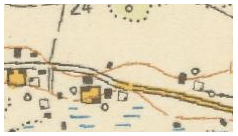
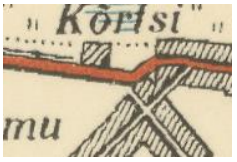
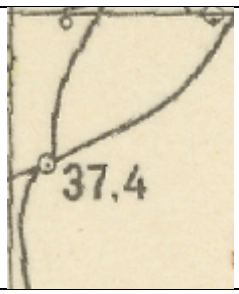
- population: no. of people,
- employment: occupation, commuters,
- farm economic status: total no. of farms, average size of farms, no. of full-time farms, no. and type of cattle, no. of tractors.

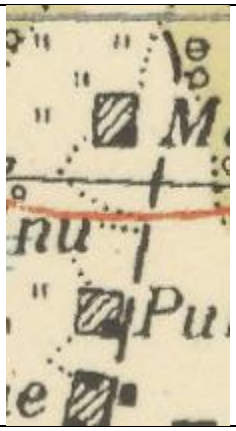
Thank you for your input!

Please return this questionnaire by 30.04.2014 (Month 5) to Anu Printsmann (anu.printsmann@tlu.ee).

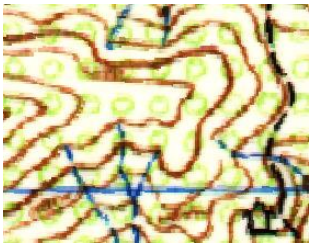
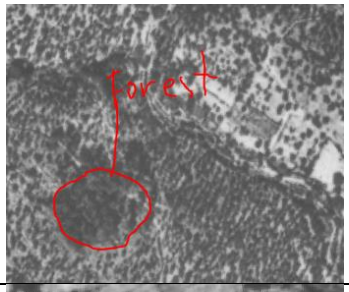
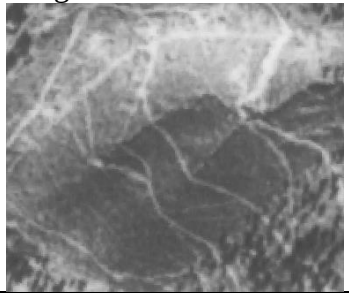
Annex 2: Legend for Estonia – Vooremaa and Kodavere – Alatskivi and Peipsiääre with map examples

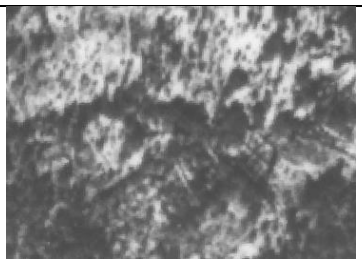
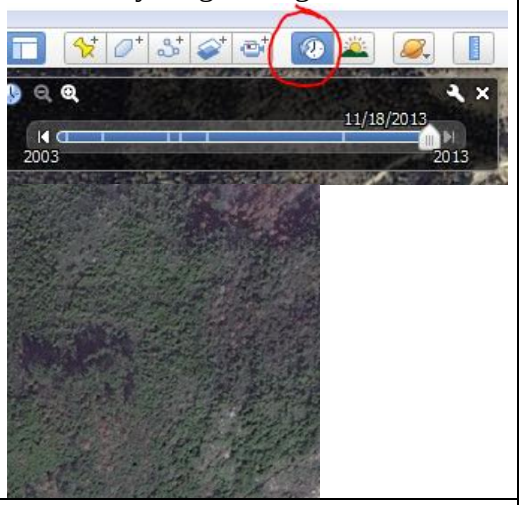
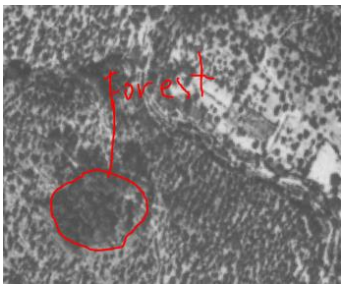
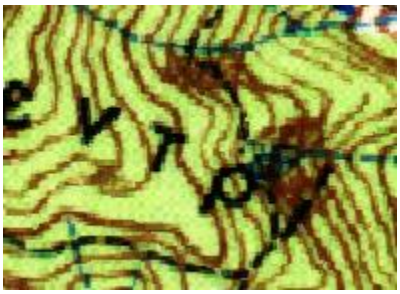
	2014	1989	1963	1938	1891
A1 Urban / Built-up					
A211 Arable land					
A311 Meadows and pastures		Signs showed on cadastral map 			
A32 Wooded grasslands and shrubs	 	Signs showed on cadastral map 			
A401Dry Forest					
A402 Wet Forest					

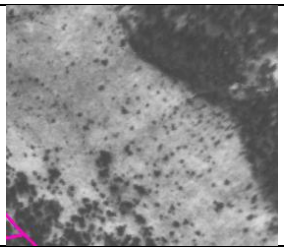
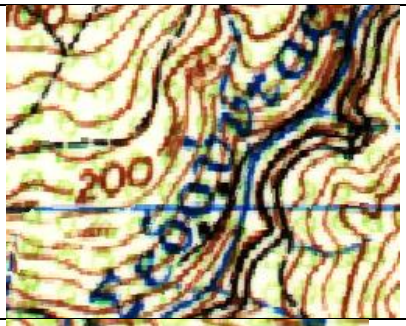
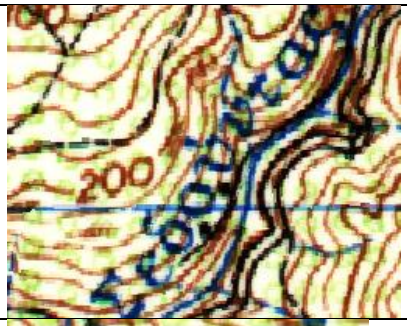
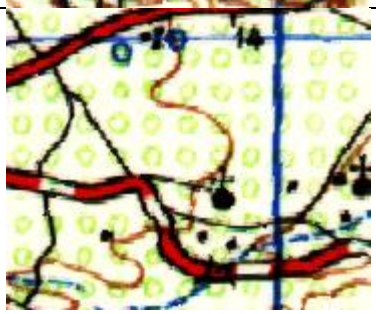
A5 Wetlands					 
A61 Standing waters					
L11 Rivers					
L12 Streams					
L13 Ditches					
L21 Main roads		Orange or white roads  	Orange or white roads 	Orange or white roads 	
L22 Side roads					

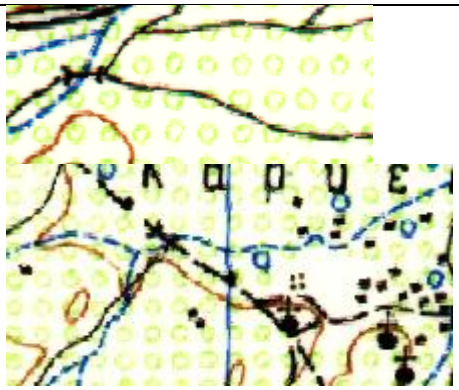
L23 Pathways					

Annex 3: Legend for Greece – Lesvos – Gera with map examples

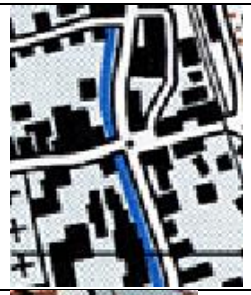
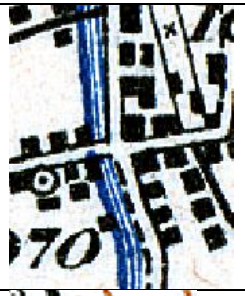
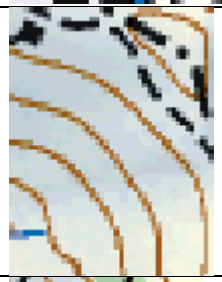
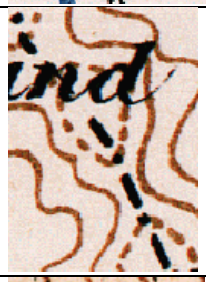
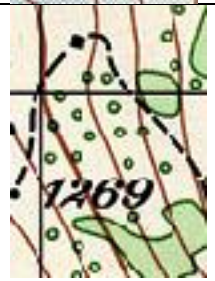
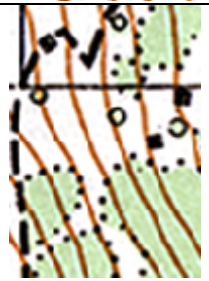
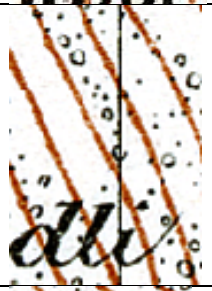
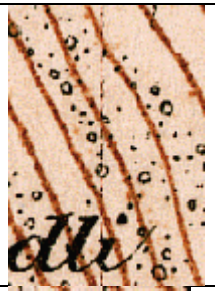
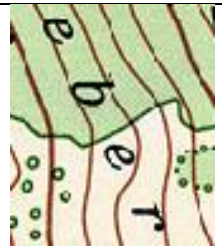
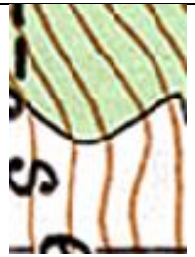
	1960 Aerial image	**2012** Aerial image from ArcGIS base maps and Google Earth
A1 Urban / Built-up (including construction areas, map only concentrated areas)		
A2 Agriculture		
A224 Olives	Practically all sparse tree stands are olive plantations. The dense tree stands are forest  	
A24 Agriculture mosaics		
A3 Grassland and shrubs		
A31 Meadows and pastures	Check the colour image from 2012 if it is a grassland or bare rock 	
A32 Wooded		Check the older maps in Google Earth

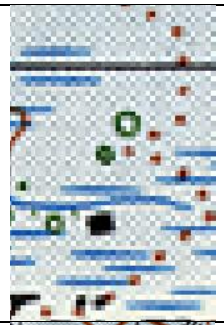
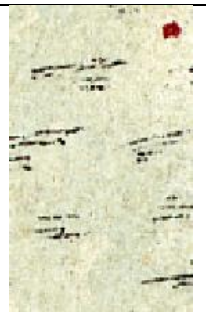
grasslands and shrubs (including Mediterranean maquis formation)		if it is not young olive growth 
A4 Forest	  Use the topographical map only if you are not sure from the aerial picture. The topographical map is not always correct	Check the older maps in Google Earth if it is not young olive growth 
A61 Standing water	No standing water in 1960	
A63 Sea	Boundary of the area is not precise. Use the seashore as the boundary (copy the layer from 2012)	Boundary of the area is not precise. Use the seashore as the boundary
A71 Natural Rock	Check the colour image from 2012 if it bare rock or grassland	

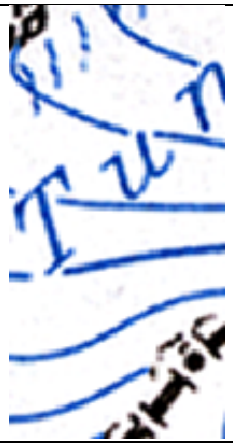
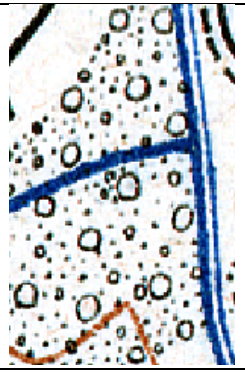
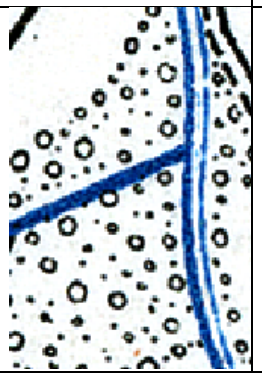
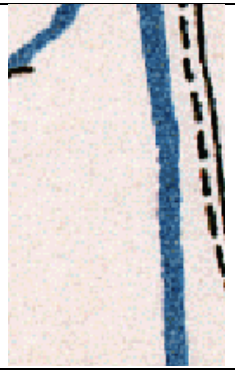
		
A74 Beach	Since there are military objects on the beaches, the aerial image is scratched on the beach areas. Use the layer from 2012 	
L11 Rivers		
L12 Streams		
L21 Main roads	 	Use the ArcGIS Basemaps – World street map. Use the topographic maps from 1970s to categorise main roads

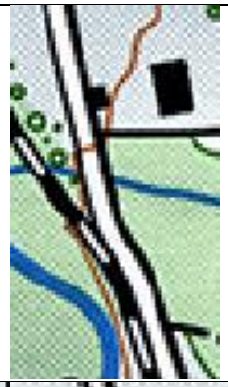
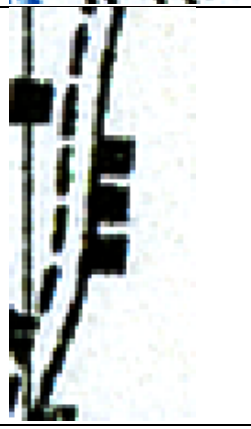
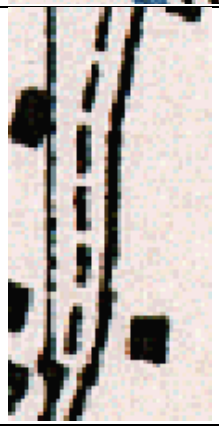
L22 Side roads		Use the ArcGIS Basemaps – World street map. Those roads that are not in topographic maps categorised as L21 Main roads are L22 Side roads 

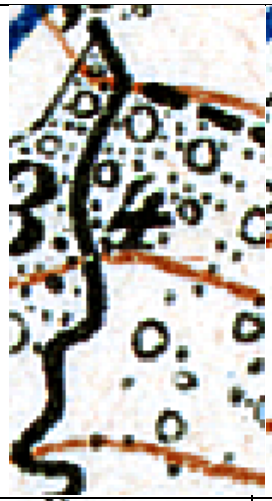
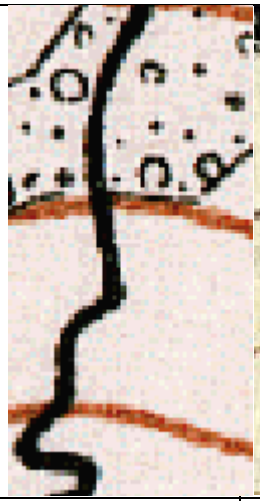
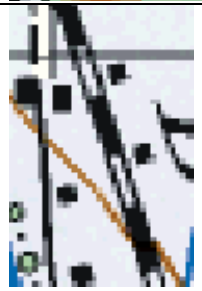
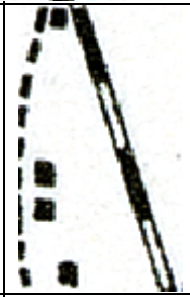
Annex 4: Legend for Switzerland – Obersimmental – Lenk with map examples

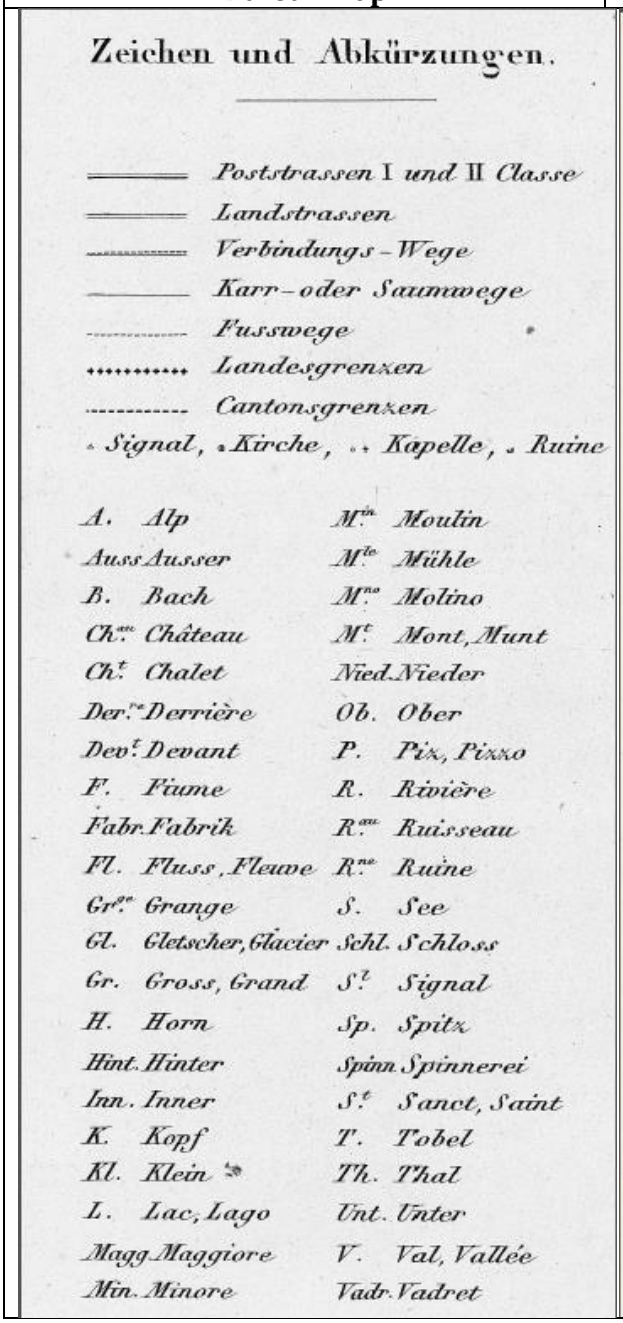
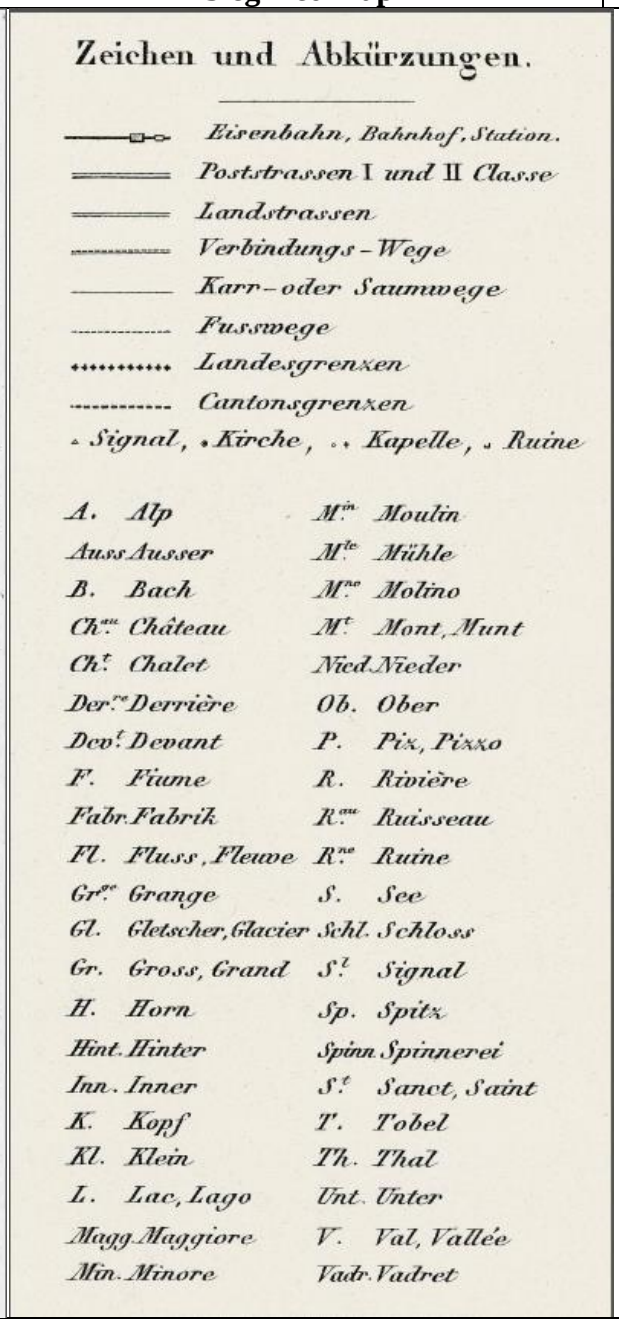
	2013	1992	1968	1935	1914	1876	1840
A1 Urban / Built-up							
A31 Meadows and pastures							
A32 Wooded grasslands and shrubs							
A4 Forest							

A5 Wetlands							
A61 Standing waters							
A71 Natural rock							

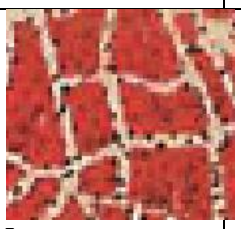
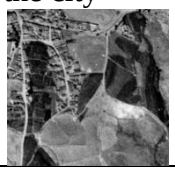
A73 Glaciers								
L1 Water								

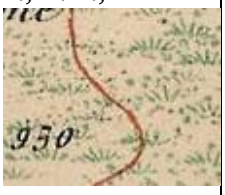
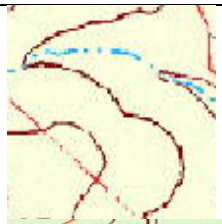
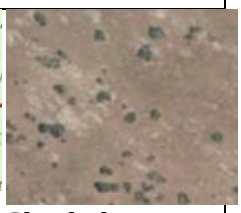
L21 Main roads								
L22 Side roads								

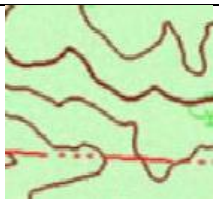
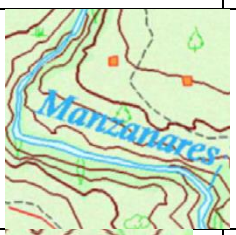
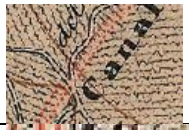
L23 Pathways								
L3 Railways								
L4 Cable cars								

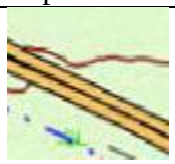
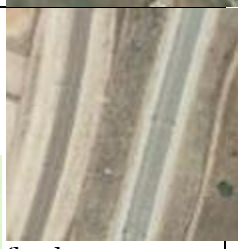
Dufour map	Siegfried map
	

Annex 5: Legend for Spain – Sierra de Guadarrama foothills – Colmenar Viejo with map examples

	1875 Topographical maps and parcel maps	**1946** Aerial picture (BW). If you need the more detailed view check the Planea server → *Fotos aeras historicas* → *1946*	**1971, 1988** Topographical maps with parcels (BW) – aerial pictures for verification available at Planea. Quarries 1967 and Quarries 1972	**2000** Topographical map from WMS. Aerial pictures for verification available at Planea	**2012** Aerial picture 2012, Open street map from from ArcGIS basemaps. Parcel maps from sigpac server. Aerial picture from 2014 (for updating) available at Planea
A1 Urban / Built-up (including construction areas)	 J.,				
A2 Agriculture					
A21 Seasonal agriculture	T.C., C., Ar., T., T.C.C., H., P.p.	Use the layer from 1971 add "huertas" located southern from the city 	R. Regadio S. Secano Tierra de Cultivo	Taken from sigpac 2014	Check the http://sigpac.mapa.es/fega/visor , zoom to detail scale, activate *Parcelas* and *Recintos*, use *Consultas tool – Recinfo*, look for TA
A221 Orchards	F., F.C., N.L., C.s., A., N., M.s., A.a.H.,H., N., 		Fr. Frutales	Not exist	Check with the sigpac the orchards are FY, FS, FL (maybe this polygon close to new railway is the only one) 

A222 Vineyards	V., O., V.P., 		V. Vinedo	Not exist	Not exist
A224 Olives	O., O.s.,  I have not seen any		O. Olivar	Not exist	Check with the sigpac the Olives are OV, OF (maybe this polygon close to new railway is the only one) 
A24 Agriculture mosaics			Not exist	Not exist	Not exist
A3 Grassland and shrubs					
A31 Meadows and pastures	P., P.A., 		Pd. Prados y dehesas, Ep. CHECK WITH THE AERIAL IMAGE if it is not A32 in real	  CHECK WITH THE AERIAL IMAGE if it is not A32 in real	 Check the map from 2000 how are the boundaries between A31 and A32 distinguished
A32 Wooded grasslands and shrubs	E.P., D.P. 		Er. Erial Mb. Monte bajo CHECK WITH THE AERIAL IMAGE if its not A31 or A4 in real	 CHECK WITH THE AERIAL IMAGE if its not A31 or A4	 Check the map from 2000 how are the

				in real	boundaries between A31, A32, A4distinguished
A4 Forest	M.a.E., M.a.P., M.b.E., M.b.P. 		Ma. Monte alto		 Check the map from 2000 how are the boundaries between A32 and A4 distinguished
A72 Quarries	C.	Check the location of the quarries on the map Quarryies_1934 (east and west)	Check the map of Quarries_1967 and Quarries 1972. Check the date of origin from the table bellow.		
L11 Rivers (only Manzanares)					Check the oldest map for level of detailness
L12 Streams					Check the oldest map for level of detailness
L13 Channels	Redraw the line of the *Isabbel II* chanel from 2012 		Redraw the line of the *Isabbel II* and *El Atazar* chanels from 2012	Redraw the line of the *Isabbel II* and *El Atazar* chanels from 2012	Topographic map from 2012 
L21 Main roads			If the road exist, use the line from 2012. If no, draw new line	If the road exist, use the line from 2012. If no, draw new line	

L22 Side roads			If the road exist, use the line from 2012. If no, draw new line	If the road exist, use the line from 2012. If no, draw new line	
L23 Pathways	Not mapped	We will not map them	We will not map them	We will not map them	We will not map them
L24 Highways	Not exist		If the road exist, use the line from 2012. If no, draw new line		
L3 Railways	Not exist	Re-draw the line of old railway from 2012.	Re-draw the line of old railway from 2012.	Re-draw the line of old railway from 2012. 	 (both are railways on right side is the new one)

Quarries with the year of origin (see the map of quarries)

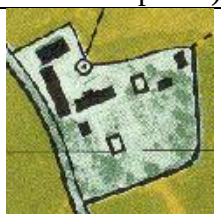
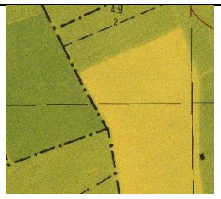
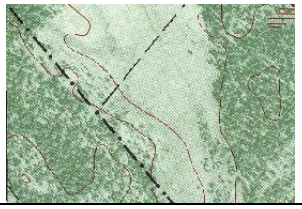
LEYENDA

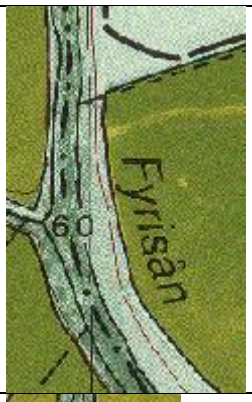
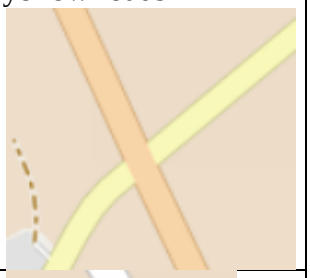
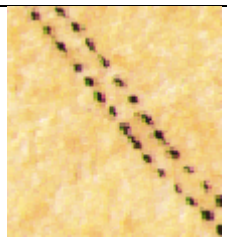
● cantera de granito
▬ cantera de pórfido
1934 fecha documentada

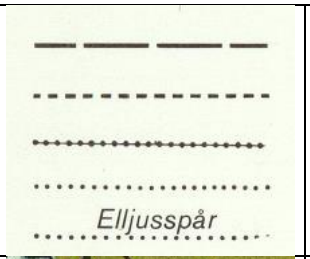
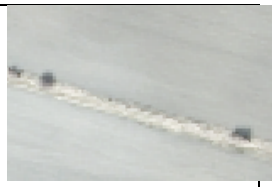
PRINCIPALES CANTERAS EN COLMENAR VIEJO

1.- Molino de Viento: ▬ ● 1926
2.- Pozo Escalo: ▬ 1926
3.- Fuente Santa: ▬ 1934
4.-Mataspulgas: ● 1934
5.-Peñote de la Zorra: ▬ 1934
6.-San Andrés: ● 1957
7.-La Bastiana: ▬ ● 1934
8.-El Redondillo: ● 1957
9.- La Magdalena: ● 1926
10.-Arroyo Pozanco – El Rosario: ● 1926
11.-Alto Tejada: ● 1915-16
12.-La Pola – Cerca Monte – El Cartero: ● 1957
13.-Tejada y sus Huelgas: ▬ ● 1915-16
14.-Suerte de las Canteras: ▬ 1957
15.-El Circuito: ▬ ● 1934
16.-Vado de la Tabla – El Patrón: ▬ ● 1957
17.-Las Cuevas: ▬ ● 1957
18.-Alto Navallar: ● 1957
19.- El Pedreño – Huelgas Manzanares: ● 1967
20.- Navallar: ▬ ● 1957
21.- Huerto Morando: ▬ 1934
22.-Estación: ▬ 1934
23.- Boca del Infierno: ▬ 1934
24.- Las Martas: ▬ 1934
25.- El Acotado: ▬ 1926
26.-La Cañada: ▬ ● 1934
27.-Tres Mantecas – Portachuelo: ▬ ● 1934
28.-Corral Cantos Colorados: ▬ ● 1934
29.- Cerca el Ligero: ▬ 1957
30.-Los Aviones: ▬ ● 1967
31.-Grajal: ● 1967
32.-Río Manzanares – Presa Grajal: ▬ ● 1957
33.-Camino Navarrosillos – Las Carrizosas: ●
34.-Marmota (actualmente en término de T.C.): ● 1957
35.- Vado Tabla – Huelgas Manzanares: ▬ 1934
36.-La Mueda: ● 1967
37.- Las Cabezas: ● 1967
38.- Los Mijares: ● 1967
39.-La Dehesa: ●
40.- Arroyo Espino: ● 1957
41.- Matamaello: ●
42.- Hueco de los Canteros: ●
43.-Majuelo: ●

Annex 6: Legend for Sweden – Uppland – Börje with map examples

	1861 Topographical map	**1945, 1977** Economic map (overlay of map and orthophoto)	**2012** Orthophoto (January 2012)
A1 Urban / Built-up		 Houses + yards	 Houses + yards
A2 Agriculture			
A211 Arable land			 ArcGIS basemaps → imagery will help to distinguish from the A31
A3 Grassland and shrubs			 ArcGIS basemaps → imagery will help to distinguish from the A211
A4 Forest		Including clearcuts and regenerating forest 	Including clearcuts and regenerating forest 
A61 Standing waters	Copy the water bodies from 2012	Copy the water bodies from 2012	

L11 Rivers Only Fyrisån river			
L12 Streams			
L13 Channels	Copy the channels from 2013	Copy the channels from 2013	
L21 Main roads		Try to keep the difference between L21 and L22 as it is in Open street maps 	Check ArcGIS base maps → Open street maps → orange and yellow roads 
L22 Side roads		Try to keep the difference between L21 and L22 as it is in Open street maps 	
L23 Pathways		(keep the level of detailnes from 1861)	Paths visible from aerial picture (keep the level of detailness from 1861)

			
L3 Railways	Not exist