

Evaluation of landscape changes in Lithuania in the second half of the 20th century

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Transformation of Lithuanian landscape cover structure in 1957–2000 (scale 1 : 50,000). The purpose of this work was to find land cover dynamics peculiarities in different natural landscapes. The reference site method was used. Landscape cover elements were chosen depending on the scaling possibilities: farmlands and meadows, forests, settlements, roads (main and small), streams, lakes and ponds, swamps (in forests and in open areas), sea, beach.

Key words: landscape cover, transformation dynamics, structure

INTRODUCTION

Studies of landscape dynamics became especially relevant at the beginning of the 21st century. This was mainly predetermined by political reasons: land restitution and privatization of forests, water bodies and farmlands.

Notwithstanding the relevance of the issue, complex studies in this field are rather scanty. The CORINE cover project has been designed for a detailed analysis of the Lithuanian land cover dynamics within a short timespan of five years. The ultimate new data on the land cover dynamics, obtained by decoding aerophotographs, can be pointed out as the main advantage of this project (Lietuvos... 2000; 2004). A very small scale of the CORINE survey making led to difficulties in distinguishing some elements important for Lithuanian landscape (e. g. small bogs, ditches, small roads, individual farms, etc. are omitted missed in the CORINE method). Among works investigating the dynamics of main landscape elements on a detailed scale, the research carried out by N. Eitmanavičienė (Eitmanavičienė, 1994) can be mentioned. It deals with the dynamics of forest, pastures, natural meadows, water bodies and roads since the oldest times until the middle of the 20th century. The dynamics of cultural landscape elements is discussed in the research works by F. Kavoliutė (Kavoliutė, 1993; 2002; 2004) and G. Ribokas (Ribokas, 2002).

Explicit studies of landscape components are devoted to various regions. Most of these studies were ordered (environmental effects, monitoring documentation, regional investigations, etc.).

This investigation deals with the development of landscapes of basal till plain, karst and sea coast regions of Lithuania in the second half of the 20th century. An evaluation of the dynamics

of hilly morainic, fluvio-glacial and fluvial landscape land cover elements was presented earlier (Bauža, 2007).

The aim of the present work was to compare landscape dynamics of different natural base genesis and farming possibilities in the second half of the 20th century.

METHODS

The work was done by the method of cartographic analysis of reference sites. The reference site method allows choosing a territory with typical landscape and exclude the problem of strict natural boundaries.

The landscape reference areas chosen from the cartographic analogous material are digitized. Databases for different timespans of the territory were compiled using the ArcView 8.1 computer program. The area of established parameters, percentage and densities of linear objects were calculated. The area of linear objects is inaccurate because of non-scale marking in maps, so in the text we describe the density of linear objects, and their area is used only for calculating the total area. As a result of such inaccuracies, the total area of for the basal till reference site in 1957 and 2000 differs by 0.001%, of karst 0.04% and of the sea coast plain by 0.33%.

The selected structural landscape elements do not fully correspond with the classical concept of landscape components. Instead of a detailed vegetation cover description (Lietuvos..., 2000; 2004) we used generalized territorial units of forests and farming lands as more easily distinguished and more suitable for describing long-term changes in the second half of the 20th century. The non-drained territories and water surfaces are represented by non-forested swamps, forest swamps, water streams, lakes and ponds. The marine and beach types of

the coastal reference site were distinguished. The other distinguished and analysed landscape elements are of cultural origin: cities, villages and rural settlements, individual farmsteads, main roads, small roads, and buildings of different purpose as live-stock buildings, named farms, etc.

REFERENCE SITES AND THEIR INVESTIGATION

The reference sites are situated in the Nevėžis lowland (basal till formation), Mūša–Nemunėlis lowland (surface reworked by karst processes) and coastal plain (coastal accumulation) (Figure).

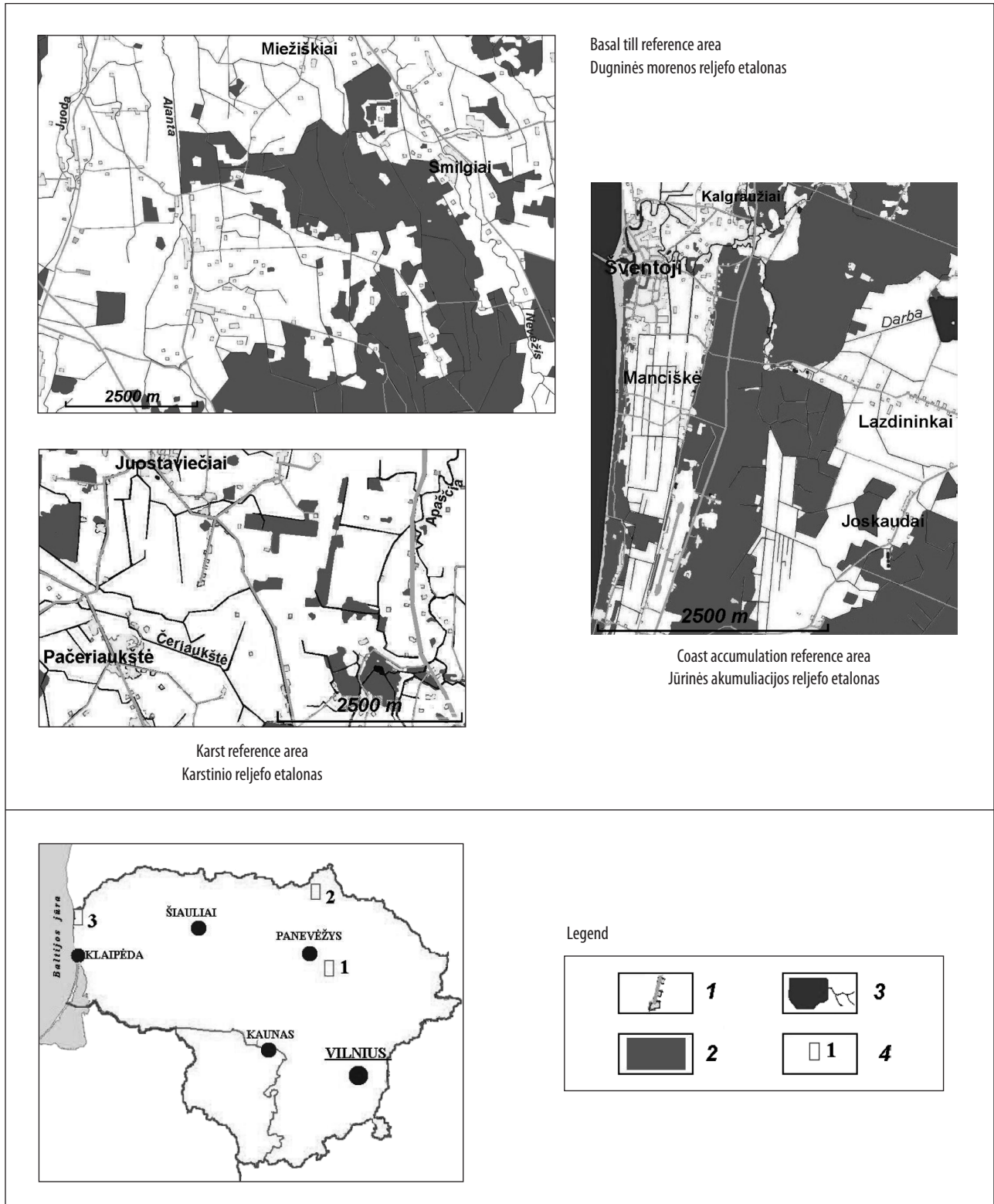


Figure. Plain relief reference areas (legend: main land cover categories: 1 – settlements, roads, 2 – forests, 3 – water bodies and streams, 4 – location of reference areas in Lithuania)

Pav. Tiriamai etaloniai ir jų lokalizacija. Pagrindinės žemės dangos kategorijos: 1 – gyvenvietės, 2 – miškai, 3 – vandentėkmės, 4 – vietovių lokalizacija

The first (1) reference site of basal till relief on the Panevėžys district had been least investigated from the point of landscape dynamics.

The reference site of basal till relief (1) is situated in the Nevėžis plain, the northern part of the Miežiškiai–Pagirys microregion (Basalykas, 1965; 1977). This locality is characterized by steep clayey flat and loamy landscapes with shallow valleys with inclusions of a wavy landscape with hollows. The territory includes rather large forest tracts (the south-western part of the investigated basal till reference area is occupied by the Nėriškiai forest tract). Agriculture is highly developed in this territory due to its relatively flat surface. The basal till reference area is 126.907 km².

Many scientific and scientific-popular publications are devoted to the karst region. Its water bodies are the best investigated landscape component. The hydrography of the karst region was exhaustively studied by K. Kilkus, J. Taminskas (Kilkus, Taminskas, 2000) and J. Taminskas, K. Dilys (Taminskas, Dilys, 2000). The complex work about the Lithuanian karst region (Šiaurės Lietuvos, 2000) contains a lot of material about all landscape components, land use, issues of human geography, cities, etc. This generalizing work contains much relevant information about the karst region. Moreover, a long-term (12 years) monitoring has been carried out in the karst region, designed for observing water level fluctuations and other parameters.

The dynamics of some land types (they can be identified by landscape elements) of the karst region was investigated in 1930–1990. The spatial structure changes of arable land, meadows and natural pastures, forests, bogs, and shrubberies was the object of these investigations (Šiaurės Lietuvos..., 2000). The landscape structure was also analysed by L. Petrokienė and G. Ribokas (Petrokienė, Ribokas, 1997). This work is deals with the ratio of karst lands used for farming and lands unaffected by karst processes. Some conclusions about landscape structure changes were done, namely about the dynamics of forests, arable land and bogs in 1972–1988.

The karst landscape reference area is situated between the Mūša–Nemunėlis plain, the Biržai microregion and the Žemgala plain and the Puodžiai–Smilgiai microregion (Basalykas, 1965; 1977). The most typical landscape elements of the Biržai microregion are a loamy wavy landscape with small hollows and lakes and a loamy landscape with small bogs and hillocks.

The Puodžiai–Smilgiai microregion has an undulating loamy landscape. The territory is dissected by many streams, whereas the distribution pattern of forests is very different from the above described in the basal till reference area, i. e. smaller forest quarters are dominant. The karst landscape reference area is 60.377 km².

A comprehensive list of references on the karst region is contained in a complex selection (Milius, 2000). Yet it must be noted that, except J. Milius' study of land types, the majority of other investigations are related to karst hydrology, hydrogeological and geological settings, prediction of karst processes and agroecological conditions in the landscape of the karst region alone.

The coastal region (3) has been investigated mostly by coastal research and aeolian relief specialists. We are going to discuss only the sources devoted to landscape transforma-

tions in a concrete territory: a coastal plain between Šventoji and Kontininkai. The Šventoji settlement and the beach north of it are most conspicuous objects in this territory. The landscape of this territory has not been specially investigated. Most works are based on coastal research data obtained within ordered works: the coastal atlas, historical and modern investigations of the Šventoji port, and investigations of the foredune ridge by V. Minkevičius, G. Žilinskas, R. Žaromskis and others (Minkevičius, Žilinskas, 2000; Žaromskis, 1998).

The coastal accumulation reference area (3) is situated in the north-western part of Karklininkai–Rudaičiai settlements in the West Žemaičiai plain and in the Palanga–Šventoji microregions (Basalykas, 1965; 1977). The first type of sandy loam landscape is composed of large flat lobes, and the second type is represented by aeolian (hillocky sandy) forms and flat boggy forest areas. Almost the whole territory is suitable for farming (the area of coastal accumulation reference area is 73,367 km²), but in comparison with basal till and karst landscapes the value of farming land differs in some cases twice (Cadastre..., 1989).

All these landscapes were described by the famous scientist A. Basalykas in relation to land use in the middle of the 20th century; therefore, various discrepancies are possible today.

CHANGES OF FOREST COVER

In the reference area of basal till (1), forests occupied 27.15% of the territory according to the data of 1957 (Table 1). Most of these forests was represented by the north-eastern part of the Nėriškės forest. The forest is highly dissected in its perimeter by roads and drainage channels. Other forest tracts of this territory were considerably smaller. In 2000, the area of forests in this basal till reference area slightly increased up to 28.51%. The increase is related to the reduction of buffer zones due to the wear of drainage channels.

The other probable reasons for a slight increase of the forest area can be related to the increase of the area of rural and urban settlements.

In 1957, the forest area in the reference site of the karst landscape (2) was smaller than in the basal till reference area and accounted for 8.50% of the total area of the territory (Table 1). According to J. Milius' data, in 1990 forests in the Pačeriaukštė environs accounted for 6.5% (Milius, 2000). The small forest area was mainly predetermined by good drainage conditions in the karst region. For this reason, the areas free of karst processes were adapted for farming. Arable fields have become the dominant form of land use. The situation was almost the same in 2000. The area of forest increased up to 12.92%. Yet this trend is related to the reduction of farmland because of political and economic reasons. After the land restitution, most of landowners developed extensive agriculture. The slight increase of the forest area is also related with the wear of drainage systems and overgrowing of buffer zones by low-quality stands. Therefore, the number of small tracts of forests increased.

In 1957, in the reference area of coastal landscape (3), forests occupied 37.82% of the territory. The forest areas were evenly distributed, i.e. the Kalgraužiai and Želviai forest tracts were extending in the meridional direction, reducing in area only near the Mančiškės settlement. The forest in the Paliepgiriai environs

Table 1. Structural changes of landscape in the reference areas in 1957–2000

1 lentelė. Kraštovaizdžio struktūros kaita tiriamose teritorijose 1957–2000 m.

Type of landcover / <i>Kraštovaizdžio elementai</i>	1957		2000	
	Total area, km ² (km / km ²)	%	Total area, km ² (km / km ²)	%
1. Basal till landscape reference area / <i>Duginės morenos etalonas</i>				
Farmlands and meadows / <i>ž. ū. naudmenos</i>	83.902	66.11	81.631	64.32
Forests / <i>miškai</i>	34.455	27.15	36.178	28.51
Forest swamps / <i>miško pelkės</i>	0.307	0.24	0.000	0.00
Swamps / <i>pelkės</i>	0.222	0.17	0.000	0.00
Lakes and ponds / <i>ežerai ir tvenkiniai</i>	0.004	0.00	0.000	0.00
Streams / <i>vandentėkmės</i>	4.699 (1.785)	3.70	3.876 (1.629)	3.05
Towns / <i>miestai</i>	0.363	0.29	1.079	0.85
Rural settlements / <i>gyvenvietės</i>	0.226	0.18	0.618	0.49
Farms, etc. / <i>fermos</i>	0.234	0.18	0.000	0.00
Individual farmsteads / <i>sodybos</i>	0.566	0.45	1.123	0.88
Small roads / <i>vietiniai keliai</i>	0.525 (0.209)	0.41	1.028 (0.367)	0.81
Main roads / <i>pagrindiniai keliai</i>	1.404 (0.334)	1.11	1.375 (0.329)	1.08
Total / <i>Iš viso</i> :	126.907	100.00	126.908	100.00
2. Karst landscape reference area / <i>Karstinio reljefo etalonas</i>				
Farmlands and meadows / <i>ž. ū. naudmenos</i>	50.373	83.52	45.381	75.21
Forests / <i>miškai</i>	5.132	8.51	7.796	12.92
Forest swamps / <i>miško pelkės</i>	0.033	0.05	0.000	0.00
Swamps / <i>pelkės</i>	0.298	0.49	0.000	0.00
Lakes and ponds / <i>ežerai ir tvenkiniai</i>	0.044	0.07	0.056	0.09
Streams / <i>vandentėkmės</i>	2.206 (1.520)	3.66	2.060 (0.474)	3.41
Towns / <i>miestai</i>	0.254	0.42	1.854	3.07
Rural settlements / <i>gyvenvietės</i>	0.186	0.31	0.794	1.32
Farms, etc. / <i>fermos</i>	0.198	0.33	0.000	0.00
Individual farmsteads / <i>sodybos</i>	0.311	0.52	1.125	1.87
Small roads / <i>vietiniai keliai</i>	0.527 (0.504)	0.87	0.846 (0.419)	1.40
Main roads / <i>pagrindiniai keliai</i>	0.752 (0.421)	1.25	0.425 (0.406)	0.70
Total / <i>Iš viso</i> :	60.314	100.00	60.337	100.00
3. Coastal accumulation landscape reference area / <i>Jūrinės akumuliacijos reljefo etalonas</i>				
Farmlands and meadows / <i>ž. ū. naudmenos</i>	28.703	38.08	30.746	40.93
Forests / <i>miškai</i>	28.504	37.82	30.869	41.09
Forest swamps / <i>miško pelkės</i>	2.504	3.32	0.000	0.00
Swamps / <i>pelkės</i>	1.341	1.78	0.265	0.35
Lakes and ponds / <i>ežerai ir tvenkiniai</i>	0.431	0.57	0.616	0.82
Streams / <i>vandentėkmės</i>	3.133 (1.352)	4.16	2.425 (1.614)	3.23
Towns / <i>miestai</i>	0.488	0.65	1.321	1.76
Rural settlements / <i>gyvenvietės</i>	0.409	0.54	0.846	1.13
Farms, etc. / <i>fermos</i>	0.195	0.26	0.264	0.35
Individual farmsteads / <i>sodybos</i>	0.494	0.66	0.522	0.69
Small roads / <i>vietiniai keliai</i>	1.549 (0.874)	2.06	1.437 (0.854)	1.91
Main roads / <i>pagrindiniai keliai</i>	0.755 (0.237)	1.00	0.774 (0.323)	1.03
Sea / <i>jūra</i>	5.539	7.35	4.050	5.39
Beach / <i>pliažas</i>	1.323	1.76	0.984	1.31
Total / <i>Iš viso</i> :	75.368	100.00	75.119	100.00

south of Mančiškės was boggy and more intensively drained. The other part of the forest was situated in the south-eastern part of the reference area. It was represented by the north-western part of the Joskaudai forest. It should be noted that coastal forests produced timber of higher quality than in other reference areas. In coastal forests, pines and spruce with scarce alders prevailed.

According to the data of 2000, the area of forests in the coastal accumulation reference area expanded up to 40.96%. This increase of the area is first of all related to the overgrowth of the foredune ridge by a forest in the sector between Kontininkai and Šventoji, and to an increase of the Želviai area. The area of Joskaudai forests remained unchanged.

CHANGES OF RESIDENTIAL AREAS

Residential territories are an important element of cultural landscape. Their investigation is important in terms of general aspects of landscape transformations and the history of settlement of a territory. In this work, settlements were grouped according to the number of population: individual farmsteads, villages and small rural settlements and towns. The term 'town' is here applied to a settlement with more than 20 living-houses and a crossroad (according to cartographic material). According to settlement typology, these "towns" are included into the category of medium and large villages (Vaitekūnas, 1989). Larger towns were Pečeriaukštė and Juostaviečiai settlements in the karst landscape reference area and the Šventoji town in the coastal accumulation reference area. Investigation of big towns must be carried out separately and to a smaller scale.

In 1957–2000, the urban areas increased about three-fold (0.29–0.85%). The number of settlements increased from 0.18% up to 0.49%. The increase of the area of individual farmsteads was a subjective factor, because individual farmsteads are non-scale object in maps of 1957. The number of individual farmsteads is more informative; in 1957–2000 it lowered from 114 to 343, because individual farmsteads merged with smaller settlements.

In 1957–2000, towns of the karst reference area increased markedly – from 0.42 up to 3.07%, the area of settlements increased from 0.31 up to 1.32%, and the number of individual farmsteads reduced from 178 to 88. The reduction of the number of rural farmsteads was predetermined not only by expansion of settlements, but also by other causes (e.g. deterioration of farming conditions due to appearance of new karst pits).

In 1957–2000, towns (Šventoji) in the coastal plain reference area increased from 0.65% up to 1.75%, settlements from 0.54% to 1.13%. The number of individual farmsteads reduced from 198 to 110. The change of residence areas implied an improvement of living conditions in the resort and the strengthening of the old and new settlements.

ROADS

Roads represent one of the forming factors of cultural landscape. The network of roads is related with the social development of a territory. Two categories of roads were distinguished: main roads (including transregional, transdistrict and main roads between cities) and small roads (including passable roads between boroughs, villages and groups of individual farmsteads).

In 1957–2000, the density of main roads in the basal till area reduced least among the studied areas – from 0.334 to 0.329 km/km², whereas the density of small roads increased from 0.209 to 0.367 km/km². Some larger roads lost their importance and were included into the category of small roads.

In 1957–2000, the density of main roads in the karst landscape reference area reduced from 0.421 to 0.406 km/km² and the density of small roads from 0.504 to 0.419 km/km². The reasons for the reduction of the density of main roads are the same

as in the basal till reference area. The reduction of small roads was related to the reduction of the number of farmsteads.

In 1957, the density of main roads in the coastal accumulation reference area (3) was considerably lower than in other reference areas and reached 0.237 km/km². The density of small roads was 0.874 km/km². This was related to the specific character of the territory, i. e. to the sea as a natural boundary along which there were no large roads. The high density of small roads can be explained by numerous paths leading to the sea or to the settlements on the sea coast. In 2000, the density of main roads slightly increased up to 0.323 km/km² and the density of small roads reduced to 0.854 km/km². The density of main roads increased due to expansion of Šventoji, and the density of small roads reduced due to appearance of new coastal settlements.

Thus, we may assume that changes in the density of the road network were related not only to the development of settlements, but also to different natural factors. Yet the latter were important only to a limited extent (except the coastal accumulation reference area (3) where the sea was and is the decisive factor in the development of the network of roads).

CHANGES OF WATER STREAMS

Water streams include natural rivers and drainage channels (including canalised river channels). This distribution is designed for finding not the quality of water streams but their changes as landscape elements. The hierarchy of drainage channels was not detailed.

The main Middle Lithuanian River Nevėžis and some of its tributaries (Juoda, Alanta and Juosta) flow across the basal till reference area. In 1957, the river-beds of the Juoda and the Juosta were natural, whereas in 2000 only part of the Juosta River remained natural. In 1957, the density of the network of streams in this reference area reached 1.785 km/km². This value was considerably higher than the density of roads. In 2000, this value reduced to 1.629 km/km². The slight reduction of the density of water streams was related with reducing natural water streams.

Rivers of the karst landscape reference area belong to the Lielupė basin. Among larger rivers we can mention the Čeriaukštė and the Apaščia. The Čeriaukštė river-bed was canalised in 1957, whereas the Apaščia remained natural. In 1957, the density of water streams reached 1.520 km/km². All streams bore the character of drainage channels. In 2000, the density of streams considerably reduced (to 0.474 km/km²) because some forest drainage systems had become inactive.

Rivers of coastal accumulation reference area belong to the Šventoji basin. The Šventoji port was long ago established in the Šventoji mouth. There are plans to restore this port (Žaromskis, 1998). The reference area also includes the confluence of the Šventoji and its largest tributary, the Darba (Kilkus, 1998). In 1957, the density of streams in this reference area (3) was 1.352 km/km². In 2000, it increased up to 1.614 km/km² due to an increase of the network of drainage channels in the approaches to the Šventoji resort.

CHANGES OF FARMLANDS AND MEADOWS

The term 'farmlands and meadows' in this work are applied to all plots of land unoccupied by distinguished landscape structural elements (Table 1). Farmlands and meadows include arable lands, pastures, meadows and other open drained territories.

In 1957–2000, farmlands in the basal till reference area reduced from 66.11% to 64.32%, in the karst reference area from 83.49 to 75.31% and in the coastal reference area increased from 38.08% up to 40.80%. These indices best illustrate the suitability of the territories for farming. Good drainage conditions in the karst region favoured a rapid development of agriculture. The proportion of farmland in this reference area was the highest. The small territory of farmland in the coastal reference area was predetermined by the specific regional character: relatively large forest tracts and soils (sand) unfavourable for agriculture. The marked reduction of farmland in the karst landscape reference area was first of all predetermined by the expansion of formerly small forests due to the wear of drainage systems and expansion of settlements at the expense of farmland. The reduction of farmland in the basal till reference area was slight and caused by the mentioned factor of the wearing down of the drainage system. Drainage was the main reason for the increase of farmland in the coastal reference area.

CHANGES OF OTHER STRUCTURAL ELEMENTS

Other structural landscape elements include live-stock farms, lakes and ponds, bogs, forest bogs and (in the coastal reference area) beaches.

Lakes and ponds are least subject to changes. In 1957, the area of lakes and ponds in the basal till reference area accounted for less than 1% of the territory. In 2000, there were no lakes or ponds remaining. In 1957, the area of lakes and ponds in the karst reference area accounted for 0.07%. In 2000, their area increased up to 0.09%. The increase of the number of lakes and ponds in the coastal plain reference area was more pronounced: from 0.57% in 1957 to 0.82% in 2000.

The area occupied by stock-breeding farms and other industrial objects reduced in the basal till reference area and the karst landscape reference area. Only in the coastal accumulation

reference area the proportion of these objects slightly increased (Table 1).

Greater changes occurred in the area occupied by bogs and forest bogs, which in the basal till reference area in 1957 occupied 0.42% of the total territory. In 2000, this area reduced to 0%. In the karst reference area, they occupied 0.55% and 0% and in the coastal plain 5.1% and 0.35%, respectively. Drainage was the main cause of the disappearance of bogs. The first two reference sites had no large bogs. In 1957, the situation was different in the coastal plain reference site. A large bog was situated in the Kalgraužiai forest (northern part of the reference area), and a drained plain bog was situated south of it. In 2000 these bogs disappeared due to drainage.

THE MAIN CAUSES OF CHANGES

The main causes of landscape transformations can be divided into political-economic and natural ones. Political-economic causes are related with changes of land ownership, use and assimilation. The land use cardinally changed after the land reform in the last decade of the 20th century.

The lands of collective and state farms were returned to the Lithuanian landowners of the inter-war period or to their descendants. These changes led to the reducing of farming land. Naturalization processes are reflected by forest, forest swamps and swamp land cover type dynamics.

All the examined changes in plain and non-plain landscape (Bauža, 2007) are summarized in Table 2. Landscape elements were divided to three categories. The first category includes four types of land cover: farmland and natural territories (farmlands, meadows, forests and swamps), the second comprises natural and artificial water-bodies and streams, two types of watered land cover (or four types for coastal plain reference site), and the third category contains four types of man-made objects (roads, buildings, etc.). Many plots of land remained unattended. The basal till and fluvial landscapes changed least (3 and 4%), the karst reference site changed most – 10% (Table 2). The karst landscape is most sensitive among the studied sites, and landscape changes reflect it. A positive point in the case of karst landscape is that almost half of the changes are related to renaturalization because of the reduced water movement.

Table 2. Landscape changes (%) in 1957–2000
2 lentelė. Kraštovaizdžio kaita (%) 1957–2000 m.

Type of landcover <i>Kraštovaizdžio elementai</i>	Landscape type changes (% from total reference area) <i>Kraštovaizdžio kaita (% bendro ploto)</i>					
	Plain			Valleys and waves		
	Basal till <i>Duginės morenos</i>	Karst <i>Karsto</i>	Coastal <i>Jūrinės akumuliacijos</i>	Fluvial <i>Fliuvialinis</i>	Glaciofluvial <i>Fliuvioglacialis</i>	Hilly morainic <i>Kalvotas moreninis</i>
Farmlands and meadows / <i>ž. ū. naudmenos</i>	-1.79	-8.31	2.85	-3.07	-3.41	-3.69
Forests / <i>miškai</i>	1.36	4.41	3.27	-0.51	5.10	1.90
Forest swamps / <i>miško pelkės</i>	-0.24	0.05	-3.32	0.92	-1.56	0.53
Swamps / <i>pelkės</i>	-0.17	-0.49	-1.43	-0.03	0.69	-1.14
Lakes and ponds / <i>ežerai ir tvenkiniai</i>	0.00	0.02	0.25	-0.02	-1.20	-0.29
Stresams / <i>vandentėkmės</i>	-0.65	-0.24	-0.93	-0.03	-0.15	0.08

Table 2 (continued)
2 lentelė (tęsinys)

Type of landcover <i>Kraštovaizdžio elementai</i>	Landscape type changes (% from total reference area) <i>Kraštovaizdžio kaita (% bendro ploto)</i>					
	Plain			Valleys and waves		
	Basal till <i>Duginės morenos</i>	Karst <i>Karsto</i>	Coastal <i>Jūrinės akumuliacijos</i>	Fluvial <i>Fliuvialinis</i>	Glaciofluvial <i>Fliuvioglacialis</i>	Hilly morainic <i>Kalvotas moreninis</i>
Towns / <i>miestai</i>	0.56	2.65	1.11	2.18	1.13	0.44
Rural settlements / <i>gyvenvietės</i>	0.31	1.01	0.58	0.56	0.40	1.89
Farms, etc. / <i>fermos</i>	-0.18	-0.33	0.09	-0.10	-0.35	-0.14
Individual farmsteads / <i>sodybos</i>	0.44	1.35	0.04	0.19	-0.15	0.36
Small roads / <i>vietiniai keliai</i>	0.40	0.53	-0.14	0.05	-0.05	0.08
Main roads / <i>pagrindiniai keliai</i>	-0.02	-0.54	0.03	-0.14	-0.44	-0.02
Sea / <i>jūra</i>			-1.96			
Beach / <i>pliažas</i>			-0.45			
Renaturalization* / <i>renatūralizacija</i>	0.94	3.86	-1.48	0.39	4.22	1.33
Total changed cover / <i>Iš viso</i>	3.07	9.97	8.22	3.91	7.32	5.20
Landcover categories <i>Dangos elementai</i>	Increasing changes of landscape cover categories (landcover types number)					
Natural and agricultural territories <i>Natūralios ir ūkinės teritorijos</i>	1	2	2	1	2	2
Watered territories / <i>vandenų teritorijos</i>	0	1	1	0	0	1
Man-made objects / <i>pakeisti elementai</i>	4	4	5	4	2	4

*Renaturalization – summ of natural changes: forest, forest swamps and swamps cover.

*Renatūralizacija – natūralios gamtinės teritorijos (miško, miško pelkių ir pelkių) pasikeitimas.

However, in some anthropogenic systems (e. g. drainage systems) renaturalization processes set in. These processes also manifested in our reference areas.

Smallest changes were observed in basal till and fluvial sites. They are similar to changes in land cover categories. Fluvial landscape differs from basal till by an increase of forest swamps (Table 2), which reflects the wear-out of the drainage systems.

Very special changes occur in the coastal landscape. Totally changed cover is the second among the studied landscapes, but renaturalization processes weren't detected, so man-induced processes prevailed.

CONCLUSIONS

1. The method of cartographic analysis for investigating landscape transformations proved relevant, with rare exceptions. Due to different levels of generalization, it was most difficult to determine changes in farmsteads, channels and streams.

2. The main determining factors of landscape transformations were political-economic (responsible for farmland area reduction) and natural (renaturalization process).

3. The greatest changes occur in the karst reference site. The expansion of urban and forest areas in the reference site of karst relief was mostly related to merging of villages into larger settlements, wear-out of drainage systems, and to processes of renaturalization.

4. Smallest changes occurred in the basal till reference site. The area of settlements in the reference site of basal till relief decreased due to the reduction of farmlands, meadows and

forests, but these changes are several times smaller than in other reference sites.

5. The reduction of the area of farmlands in the chosen reference areas was predetermined by forestation and intensive renaturalization processes.

6. Landscape transformations in the coastal plain area were predetermined by human impact, first of all the expansion of the Šventoji town and the related phenomena: expansion of the territories of forested areas and settlements at the expense of farmland and drained territories.

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LIETUVOS KRAŠTOVAIZDŽIO POKYČIAI XX a. ANTROJOJE PUSĖJE

S a n t r a u k a

Naudojantis 1 : 50 000 mastelio žemėlapiais straipsnyje analizuojama kraštovaizdžio struktūrinių elementų kaita 1957–2000 metais. Darbo tikslas – nustatyti įvairaus tipo kraštovaizdžio kaitos ypatybes. Atrinktos etaloninės vietovės padėjo išvengti ribų tarp skirtingų kraštovaizdžių problemos. Pasirinkti kraštovaizdžio elementai, kuriuos galima išskirti pasirinkto mastelio žemėlapiuose: žemės ūkio naudmenos ir pievos, miškai, gyvenamos vietovės (susikirstytos pagal užimamą plotą), keliai (pagrindiniai ir smulkūs), vandentėkmės, ežerai ir tvenkiniai, pelkės (miško ir atviros), jūra, paplūdimys; lygumų kraštovaizdžio etalonai: dugninės morenos, karsto, pajūrio. Tyrimų rezultatai buvo palyginti su anksčiau nustatytais pokyčiais fluvialiniame, fluvioglacialiniame ir moreniniame kraštovaizdyje. Nustatyta, kad didžiausi pokyčiai vyko jautriausiam – karstiniame – kraštovaizdžio etalone; čia taip pat buvo intensyviausi renatūralizacijos procesai. Mažiausi pokyčiai nustatyti dugninės morenos etalone. Labai specifiniai pokyčiai vyko pajūrio kraštovaizdyje, renatūralizacijos procesų pajūryje nenustatyta.