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Papers review

ESTIMATION AND TRENDS OF LANDSCAPE TRANSFORMATION IN THE SECOND HALF OF THE 20th CENTURY

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Abstract. The transformation of landscape cover structure in 1957–2000 is the purpose of this paper. By cartographic material (maps to scale 1:50 000) the changes of landscape cover elements (forests, settlements, farmlands, roads, streams, etc) and causality are analysed. Most transformations resulted from the Agrarian Reform. Major part of the investigated territory consists of reduced farmland areas, expanded settlements and denser road networks. The study was performed in 3 reference territories with a different relief – hilly morainic, fluvioglacial and fluvial.

Keywords: landscape, forests, transformation, dynamics, structure.

1. Introduction

The second half of the 20th century abounded in political and economic events which entailed conspicuous landscape transformations. First this is true of the land reform – restitution of the state land to former owners or their descendants. Due to this the character of land use changed considerably. Liquidation of collective and soviet farms was a factor which predetermined relative reduction of farms larger than 300 ha and changed land use priorities. The reduction of farms is responsible for high diversity of farmlands, where areas of extensive farming unfortunately have become dominant. The forest area has changed for the same reason. It was reduced because of unpunished destruction of forests as a private property. The territorial development of villages produced a negative influence on the network of roads and agrotechnical systems (various drainage equipment). Cartographic material reflects all these changes. The present paper is an attempt to compare the structure of landscape cover in the middle of the period (1950–1957) and at the end of the 20th century (2000). The aim of the present paper is to find out the changes of landscape structure in different reference areas.

On the basis of available cartographic material, N. Eitmanavičienė [1] analysed in detail the causes of landscape transformation in 1865–1965. She studied the change of different landscape types in some reference areas. Yet the presented data can be useful only for comparison because the location of the chosen reference areas is not indicated.

2. Aim and methods

The period between 1950 and 2000 is studied. The landscape reference areas were chosen on the basis of landscape types distinguished by A. Basalykas [2–4] and forested Lithuanian areas studied by N. Eitmanavičienė [1]. Representativeness of the territories and objective factors predetermining possible structural changes of landscape cover were the main criteria of choice. First, the chosen territories had to include different types of land use – cultivated fields, forests, settlements, roads, etc. Abundance of natural water bodies (lakes and rivers) and bogs was also taken into consideration.

Three reference areas in different landscape types were chosen for determining transformations. The boundaries of the reference areas were drawn on the basis of cartographic material (a Russian map to scale 1:50 000). The cartographic information contained in Russian topographic maps of 1951, 1955–1956 and 1957 and in the map of Lithuania issued by the GIS Centre in 2000 (1:50 000) (CD) was employed. Fragments with plotted reference areas of both maps were digitized. Based on the results of data processing, elements of landscape cover were distinguished, and their area was calculated (Tables 1–3). The following types of landscape cover were distinguished: forests, forest bogs, bogs, lakes and ponds, streams, towns, rural settlements, individual farmsteads, main roads, small roads and farmlands. A similar method was used for analysis of socioecological condition in urbanized landscape [5].

The transformations of landscape cover are evaluated also within the CORINE project [6]. Yet the information obtained within the project is not exhaustive because only the largest areas (of 25 ha and more) are plotted. The territory of Lithuania goes into eight deciphered space survey photographs. The project material demonstrates the transformation trends of landscape complexes (forests, farmlands, territories under buildings, etc) within administrative units in a short span of five years (2000–2005). The material presented in many tables and maps can be used for comparison. In our work

we compared some of derived CORINE data with the information obtained from topographic maps. The smallest areas included in the present work are sized ~ 0,1 ha (area of individual farmsteads).

3. Choice and location of reference areas

The chosen standards represent various landscape types in the territorry of Lithuania. We analysed landscape trends in 3 of 8 landscape types by A. Basalykas' classification. In Lithuania this landscape area is very widespread, therefore, we analysed only landscape standards in line with an incident feature. The standards represented 3 Lithuanian landscape styles [7].

A reference area of a hilly morainic landscape was chosen in Molėtai district, in the environs of the Virinta lake (Fig). The total area of the territory is 144 264,49 ha. According to A. Basalykas' [2, 3] classification, the territory belongs to Molėtai–Labanoras and Skudutiškis–Suginčiai landscape sub-regions of Aukštaičiai Upland region. The studied territory has morainic hills, glacial channel valleys (Virinta–the Virinta lake and the Susiedas lake), swampy depressions and glaciofluvial forms.

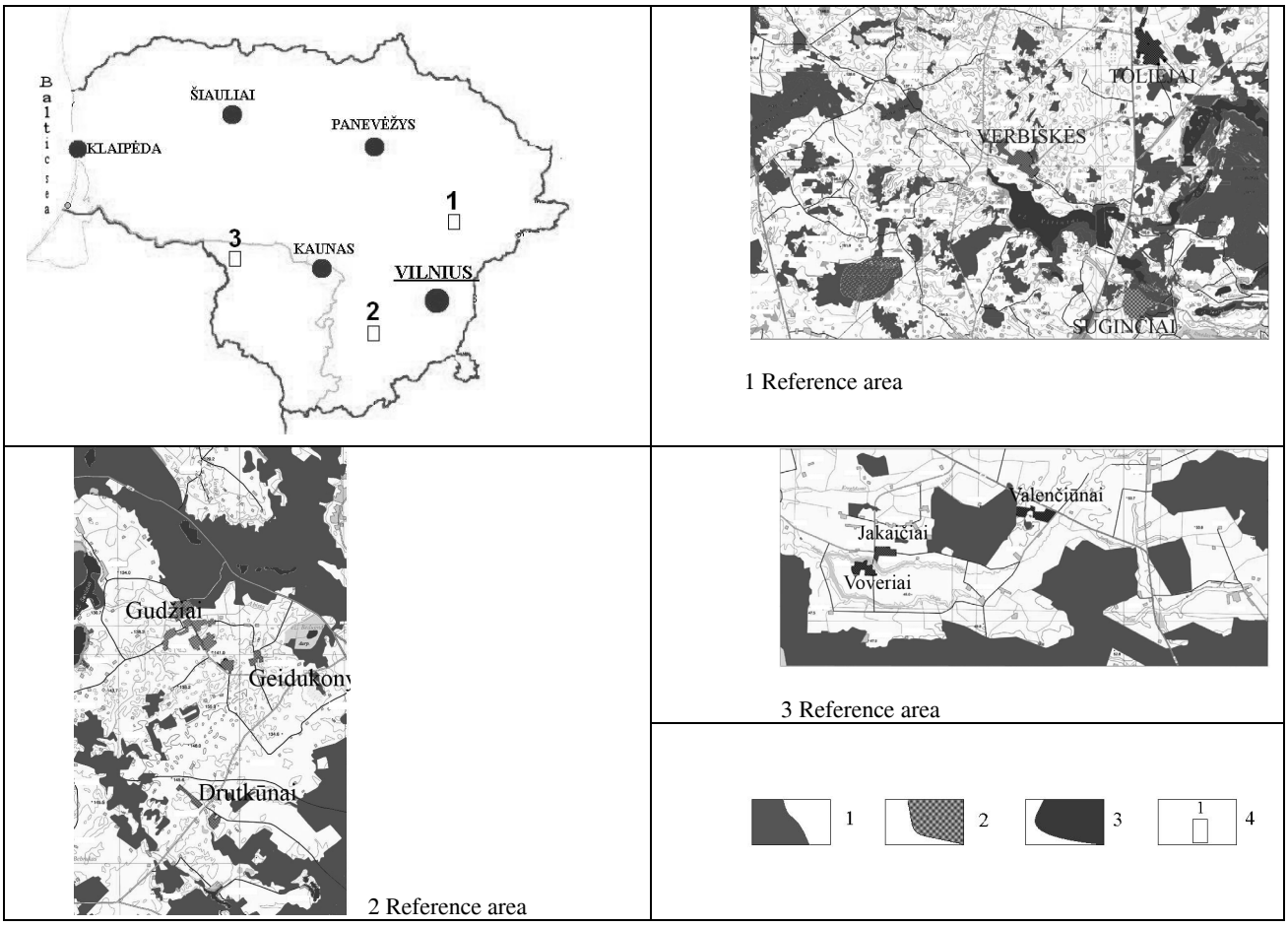
A reference area of a glaciofluvial relief is situated in two physical geographical regions. The south-eastern part is included in Varėna–Perloja sub-region of South-Eastern Plain, and the remaining part belongs to Daugai–Kalesninkai and Junčionys–Dusmenos landscape sub-regions of South Lithuania. The area of the territory is 78 905,47 ha.

The south-eastern boundary of the reference area runs in the forest south-east of Ežeriekai village. Glaciofluvial forms of Nemunas Ice Age occupy the greatest part of the territory.

The sector of the Penta river with the Totorvietė pond is a reference area of a fluvial relief in Šakiai district. The greater part of the territory is occupied by drained meadows and drainage ditches. The territory is included in Šakiai landscape sub-region of Lower Nemunas Plain physical region [2, 3]. The total area of the territory is 58 357,25 ha.

4. Forested territories of reference areas

Forested territories account only for 30–40 % of the hilly morainic landscape [1]. The structure of relief is the cause of that. Conditions for forest growing are worse in the areas with dominant hilly relief. It should be noted that the level of cultivation of these territories is better than that of plains. They have more settlements and roads. According to the data for 1950, forests accounted for 21,64 % of the studied reference area.



Location of reference areas (1 – forests; 2 – cities; 3 – lakes; 4 – reference area location in Lithuania)

Table 1. Change dynamics of landscape cover structure in reference area of hilly morainic relief

Type of land	in 1951		in 2000	
	Total area (ha)	%	Total area (ha)	%
Swamps	1587,61	1,10	8,73	0,01
Towns	1188,54	0,82	1808,09	1,25
Farms, etc	193,75	0,13	0,00	0,00
Forests	31214,92	21,64	34021,54	23,58
Forests swamps	870,14	0,60	1608,42	1,11
Rural settlements	258,50	0,18	2892,61	2,01
Small roads	0,038	0,78*	0,058	1,35*
Main roads	0,037	1,50*	0,034	1,17*
Lakes and ponds	5957,90	4,13	5589,86	3,87
Streams	0,069	2,19*	0,09	1,61*
Individual farmsteads	864,29	0,60	1374,83	0,95
Farmlands	95678,83	66,32	91009,34	63,08
Total area	144264,49	100,00	144264,99	100,00

* Area in concordance with cartographic material

Table 2. Change dynamics of landscape cover structure in reference area of glaciofluvial relief

Type of land	in 1951		in 2000	
	Total area (ha)	%	Total area (ha)	%
Swamps	225,71	0,28	748,96	0,95
Towns	144,88	0,18	1008,41	1,28
Farms, etc	262,61	0,33	0,00	0,00
Forests	21892,32	27,02	25927,83	32,86
Forests swamps	1180,09	1,49	0,00	0,00
Rural settlements	183,21	0,23	489,68	0,62
Small roads	0,036	1,61*	0,024	1,22*
Main roads	0,090	1,51*	0,038	1,12*
Lakes and ponds	2218,38	2,80	1321,37	1,67
Streams	0,091	2,83*	0,055	1,88*
Individual farmsteads	805,30	1,02	699,01	0,89
Farmlands	47630,41	60,09	45382,99	58,51
Total area	79258,64	100,00	78905,47	100,00

*Area in concordance with cartographic material

Table 3. Change dynamics of landscape cover structure in reference area of fluvial relief

Type of land	in 1951		in 2000	
	Total area (ha)	%	Total area (ha)	%
Swamps	13,88	0,02	0,00	0,00
Towns	244,13	0,42	1208,23	2,07
Farms, etc	56,96	0,10	0,00	0,00
Forests	4266,18	7,31	3315,63	5,68
Forests swamps	54,46	0,09	470,88	0,81
Rural settlements	42,04	0,07	293,29	0,50
Small roads	0,019	0,38*	0,025	0,77*
Main roads	0,052	1,55*	0,029	1,42*
Lakes and ponds	13,08	0,02	0,00	0,00
Streams	0,118	4,18*	0,093	4,13*
Individual farmsteads	187,54	0,32	244,96	0,42
Farmlands	49910,71	85,53	40123,13	84,20
Total area	58357,25	100,00	58357,25	100,00

* Area in concordance with cartographic material

Two larger forest areas can be distinguished in the north-western and eastern parts of the territory. Less forested is the territory north of Verbiškė settlement, where widespread large morainic hills were arable in 1950. Leafy shrubs grow around the Virintai and Želva lakes. Natural forests grow near farmsteads or smaller villages. The cartographic material is an insufficient basis for judging about the presence or absence of protective forest belts along roads and in river valleys.

According to the data for 2000, the area of forested territories has slightly (21,64 to 23,58 %) increased because of a higher number of small groves. The small groves have appeared due to reduced farming and drainage. Forested lakesides stand out. Forests have overgrown

almost all the perimeters of the Virinta, Želva and Graužys lakes. An elevated number of forest swamps (from 0,60 to 1,1 %) is also a consequence of forest drainage.

Forested areas of a fluvioglacial relief determined in the middle of the 20th century are larger (60–70 %). A smoother surface, rock composition and soil quality are responsible for that. Sandy and gravel sediments are unfit for agriculture. Therefore, forests are more widespread. For comparison we can mention that the grade of economic ranking of the soil in Varėna district is 36,1, whereas in Ignalina district – only 32,0 [8]. These districts are classified as the fourth (the worst) economic class of soils and are used mainly for forest growing. However, the forest area is not everywhere so large. According to the data of 1951, forests occupied 27,02 % of the reference area. Most forests concentrate around Varėna and Daugai (Geidukonys, Gudžiai and Pamusiai forests). Another rather large forest tract (Ežeriekai forest) is situated in the south-eastern part of the reference area. Contrary to the hilly morainic landscape, the present reference area has a greater number of small forests and greeneries around farmsteads. The rural settlements are concentrated what makes better conditions for expansion of forest tracts.

By 2000 the forested territory in the reference area of a fluvioglacial relief had increased from 27,02 % to 32,86 %. Forest swamps had almost disappeared. Yet this was not the main cause of forest expansion. The increase of the total area of forests was predetermined by expansion of large forest tracts in the north-eastern part of the reference area.

Forested territories in the reference area of a fluvial relief accounted only for 7,31 %. A specific character of the chosen area predetermined that. The reference area included a part of the Penta river valley and surrounding drained territories.

The territory of forests was small because of dominance of arable lands. The greeneries of the river valley stand out accounting for a larger part of all the forested territories in the reference area. Small groves can be found in some places mostly around drainage ditches and channels. The roads and the largest settlement of Valenčiūnai are not forested.

By 2000 the forested territory in this reference area had reduced to 5,68 % (compared with 7,31 %). This was predetermined by reduction of the area of small forests in farmlands. A protective forest belt along the Penta river and in drained meadows had thinned out. All that happened due to intensive use of farmlands in the second half of the 20th century.

5. Change dynamics of the number of settlements and roads in reference areas

According to the data of 1957, urban areas in the reference area of a hilly morainic relief occupied 1 181,54 ha (0,82 %), rural areas – 258,50 ha (0,1 %) and individual farmsteads – 864,29 ha (0,60 %) of the total territory. The largest settlements were Verbiškės, Suginčiai and Toliejai. The rural settlements of Padvarniai, Buržilai and Juodėnai were slightly smaller.

The network of roads in 1957 was similar to the present one, according to the total road length per unit area (Table 1). The density of the main roads (district roads with a solid pavement) reached 0,037 km/km^2, and the density of small roads was 0,038 km/km^2. In 2000 the density values were 0,034 km/km^2 and 0,058 km/km^2, respectively. The higher density of small roads is related with a rather chaotic distribution of individual farmsteads in 1957 and reduction of the relative number of these farmsteads (from 249 to 45) due to aggregation into larger villages in 2000.

The number of settlements in the reference area of a hilly morainic relief had changed by 2000. Expansion of Verbiškės and Suginčiai settlements had slightly changed the area of urban settlements – up to 1 808,09 ha (1,25 %). The area of the other settlements had increased as well (Table 1). This was related with the development of agriculture in these territories.

The largest settlements in the reference area were Gudžiai and Tolkūnai occupying 144,88 ha and accounting for 0,18 % of the total territory. Small rural settlements (Druckūnai, Ežeriekai, Tolkūnai, etc) were more numerous and occupied 183,21 ha (0,23 %). Individual farmsteads were scattered over an area occupying 805,30 ha (1,02 % of the total territory).

According to the data of 1957, the density of the network of roads in this territory was 0,126 km/km^2, including 0,090 km/km^2 of main roads. These values were higher than in the area of a hilly morainic relief because of large roads crossing the territory.

According to the data of 2000, main roads occupied 0,038 km/km^2, and small roads – 0,024 km/km^2. Different interpretation of small and main roads predetermined differences in values (in 1957 district roads with a gravel pavement were regarded as main roads).

The number of settlements in the reference area had changed conspicuously by 2000. The number of rural settlements increased almost thrice (by up to 1,28 %), and the number of urban settlements – almost ten times (by up to 1,28 %). The number of individual farmsteads was reduced by up to 0,89 %. These changes had an inverse effect on the infrastructure. The density of main roads was reduced to 0,038 km/km^2, and the density of small roads – to 0,24 km/km^2. The breakstone roads Daugai–Varėna and Alytus–Verėna were paved with asphalt and became the main roads. The remaining roads were included into the category of district roads. This accounted for the reduction of the number of main roads. Small roads were classified as paths and were not included into the category of small roads in the map of 2000.

Changes in the size of settlements were entailed by their expansion and appearance of new ones by roads.

Even less settlements existed in 1951 in the reference area of a fluvial relief. Totorvietė and Sintautai settlements were the only boroughs occupying 244,13 ha (0,42 % of the total territory). A small Gustainiškiai settlement occupied an area of 42,04 ha (0,07 %), and 91 individual farmstead occupied an area of 187,54 ha (0,32 %). The density of roads was 0,071 km/km^2, including 0,019 km/km^2 of small roads. Scanty population of

the territory and natural conditions (all settlements were situated along a river) were the causes of this distribution pattern.

By 2000 the density of small roads increased to 0,029 km/km^2, and the density of main roads was reduced to 0,027 km/km^2. The causes were similar as in the reference area of a fluvioglacial relief.

The area of settlements was larger in 2000. The expanded settlements of Valenčiūnai, Totorvietė and Sintautai increased the urban area by up to 2,07 % (about four times). The number of rural settlements increased seven-fold. The increase of individual farmsteads was negligible (0,1 %). Extensive assimilation of the territory predetermined by the political and economic events of 1951–1957 was, presumably, the cause of these changes.

Analysis of cartographic material shows that in 1951–1957 chaotically distributed individual farmsteads were most widespread. Urban areas were poorly developed. This was the time of establishment of collective farms and decay of rural settlements. Many small villages had disappeared due to forced migration, whereas new soviet settlements had not been formed yet.

Most settlements were situated by rivers irrespective of relief.

6. Change dynamics of water bodies (rivers, drainage ditches, closed water bodies, etc) in different reference areas

The density of linear streams (rivers and drainage channels) in the fluvioglacial and fluvial reference areas was reduced in the time span from 1951 until 2000 (Tables 2 and 3). A greater part of the territory is occupied by plains used for farming after reclamation. When drainage systems wore out, channels became overgrown and renaturalized. A higher density of linear water streams in a hilly morainic relief (Table 1) was an exception rather than regularity. Shorter channels and strong farms, which properly attended to the drainage systems, were, presumably, the cause of that.

Different generalization level of cartographic material, presumably, accounts for the differences of the occupied area by closed water bodies because there were no factors which could have markedly changed the area of lakes and ponds.

7. Change dynamics of farmlands in different reference areas

Territories, in which no other kinds of use were determined, are regarded as farmlands. Varying cartographic material did not allow to distinguish pastures, arable soils, gardens and other kinds of farmlands.

In 1951 farmlands occupied 66,32 % of the territory with a hilly morainic relief. The largest areas of farmlands were situated north of the Virintai lake. It should be noted that arable fields dominated in a hilly morainic relief notwithstanding its high dissection (slopes of 5–10° prevail). They were concentrated around the Virintai lake and west of it.

By 2000 the area of farmlands had been reduced. Expansion of forest areas and settlements (Suginčiai and Verbiškės) were the cause of reduction. Pastures and territories unused for farming occupied a greater part of farmlands. Farming activity in poor soils was unprofitable. The events of the last decade of the 20th century had an adverse effect on arable fields. Most arable fields of the former collective and soviet farms lay wasted or were not cultivated due to other reasons.

In 1952 farmlands accounted for 60 % of the territory of a fluvioglacial relief. Arable fields and pastures occupied the greatest part of farmlands. According to cartographic material, small fields prevailed in a greater part of the territory.

By 2000 the area of farmlands had also been reduced in a fluvioglacial relief. This happened due to expansion of other types of landscape cover (forests and settlements; Table 2). The quality of farmlands had deteriorated, and wastelands prevailed. This tendency is also observed in the reference area of a fluvial relief.

8. Conclusions

1. Comparison of the data for 1951–1957 and 2000 revealed that the forest area increased in all the reference territories. This was predetermined by forestation of forest swamps, troughs between hills and areas with worn out drainage systems. The area of forests was reduced in the fluvial-relief area due to a still intensive farming.

2. Reduction of the area of farmlands, expansion of settlements (settlement compaction) and the network of roads are the trends observed in all the reference areas.

3. The area of swamps was reduced in all the studied areas. This was predetermined by drainage. Most of larger swamps went dry and are not plotted on the maps.

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KRAŠTOVAIZDŽIO KAITOS XX A. ANTROJOJE PUSĖJE TENDENCIJOS IR JOS ĮVERTINIMAS

D. Bauža

S a n t r a u k a

Antrojoje XX a. pusėje buvo gausu politinių ir ekonominių įvykių, kurie lėmė ryškius kraštovaizdžio pokyčius. Pirmiausia tai yra žemės reforma – buvusios valstybinės žemės grąžinimas savininkams ir jų palikuonims. Dėl to pasikeitė žemės naudojimo pobūdis. Kolūkių ir tarybinių (sovietinių) ūkių panaikinimas tapo veiksniu, lėmusiu didesnių negu 300 ha dirbamų žemių santykinį sumažėjimą, žemės naudojimo prioritetų pasikeitimą. Šio darbo tikslas – išsiaiškinti kraštovaizdžio struktūros pasikeitimus įvairiuose pasirinktuose kraštovaizdžio etalonuose. Tiriamas laikotarpis nuo 1950 m. iki 2000 m. Kraštovaizdžio etalonai pasirinkti, remiantis A. Basalyko pasiūlytais kraštovaizdžio tipais [1], N. Eitmanavičienės ištirtais miškingais Lietuvos arealais [6]. Kraštovaizdžio kaitai nustatyti buvo pasirinkti 3 etalonai skirtingame kraštovaizdyje. Remiantis kartografine medžiaga (1957 m. ir 2000 m. žemėlapiais M 1:50 000), išanalizuota kraštovaizdžio struktūros kaita kalvotame moreniniame (Virintų etalonas), fliuvioglacialiniame (Daugų etalonas) ir fliuvialiniame (Pentos etalonas) reljefe. Visuose etalonuose nustatyta miškų ploto mažėjimo, gyvenviečių stambėjimo, pavienių sodybų skaičiaus mažėjimo tendencijos Žemės ūkio naudmenų ploto sumažėjimas ir gyvenviečių skaičiaus didėjimas būdingas visiems pasirinktiems etalonams.

Reikšminiai žodžiai: kraštovaizdis, miškai, kaita, dinamika, struktūra.

ТЕНДЕНЦИИ И ОЦЕНКА ИЗМЕНЕНИЯ ЛАНДШАФТА ВО ВТОРОЙ ПОЛОВИНЕ XX ВЕКА

Д. Баужа

Р е з ю м е

Во второй половине XX века произошло много политических и экономических событий, оказавших непосредственное воздействие на изменение ландшафта. Земельная реформа изменила субъекты собственности – государственная земля была возвращена собственникам или наследникам. В результате сильно изменился характер пользования землей. Отмена колхозов и совхозов стала фактором, из-за которого уменьшились условные площади сельскохозяйственных территорий, изменились приоритеты пользования землей.

Целью статьи было выявить изменение структуры ландшафта в разных выделенных эталонах ландшафта за период с 1950 по 2000 гг. Эталоны выделены на основании классификации ландшафта Литвы, составленной А. Басаликасом (1965), и лесных ареалов, описанных Н. Эйтманавичене (1994). Изменения исследовались в 3 эталонах разного ландшафта. По картографическому материалу (по топографическим картам 1957 и 2000 гг. (масштаб 1:50 000)) проводился анализ изменения структуры ландшафта в холмисто-моренном (эталон Виринтай), флювиоглациальном (эталон Даугай) и флювиальном (эталон Пунта) рельефе. Во всех эталонах выявлена следующая тенденция – уменьшение лесов, укрупнение посёлков, уменьшение численности сельских усадеб. Уменьшение сельскохозяйственных площадей происходит во всех изучаемых эталонах.

Ключевые слова: изменение ландшафта, структурные элементы ландшафта, картографический материал.

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