VYTAUTAS MAGNUS UNIVERSITY AGRICULTURE ACADEMY

BALTIC SURVEYING

19TH - 21ST CENTURIES LANDSCAPE MODELLING AND IT'S CHANGE: A CASE STUDY OF JURBARKAS DISTRICT MUNICIPALITY'S SMALININKAI ELDERSHIP (LITHUANIA)

Rūta Puzienė[1], Jolanta Valčiukienė[2]

[1]Vilnius Gediminas Technical University, [2]Agriculture Academy, Vytautas Magnus University,

Introduction

Landscape change caused by anthropogenic changes in land cover and land use is one of the most widespread consequences of human activity. Many European cultural landscapes have undergone significant changes since the nineteenth century and especially since the twentieth century. During this time, agricultural activities intensified and became increasingly concentrated in areas favourable for farming, moving from unattractive areas that have undergone renaturalisation processes over time (Bender *et al*., 2005). Accurate knowledge of historical landscape conditions and landscape change over time can facilitate and improve the prediction of current and future landscape conditions and create scenarios for the future (Marcucci, 2000). Modifying rural areas and analysing their environment and landscape is an important aspect to understand the profound changes associated with human interventions and natural phenomena (Statuto *et al*., 2014). To understand landscape evolution and rates of change, it is necessary to reconstruct and analyse past landscapes. For this purpose, old maps that contain geographically orientated information can be used. Digitizing old cartographic sources to analyse natural and anthropogenic land cover changes allows to understand the evolution of landscape change (Statuto *et al*., 2016) in order to take into account the sensitivity of the environment to anthropogenic activities. Many landscape transformation processes are almost imperceptible in the short term, but in the long term they can lead to changes in environmental conditions or water balance (Haase *et al*., 2007). In rural areas, aesthetic changes can affect various land cover components, and rural change is clearly an important variable in landscape planning. Over the last three decades, three phenomena have radically reconfigured rural areas: mechanisation, the accelerating loss of traditional rural life and the increasing mobility of people (Domon, 2011). Geographic Information System (GIS) is an excellent tool for landscape modelling and three-dimensional analysis. It allows easy digitization of geographical information, its coverage structure and graphical visualisation. Understanding landscape dynamics requires the application of spatial analysis, comparison of historical maps with modern maps (San-Antonio-Gomez *et al*., 2014) and information on geographically orientated land covers from other sources. To identify landscape changes, the study will digitize old maps and create attribute databases. The resulting data will be compared to the CORINE land cover database and analysed. The results will be visualised using ArcGIS. ***The aim*** of the analysis is to analyse landscape changes in Smalininkai Eldership.

Methodology

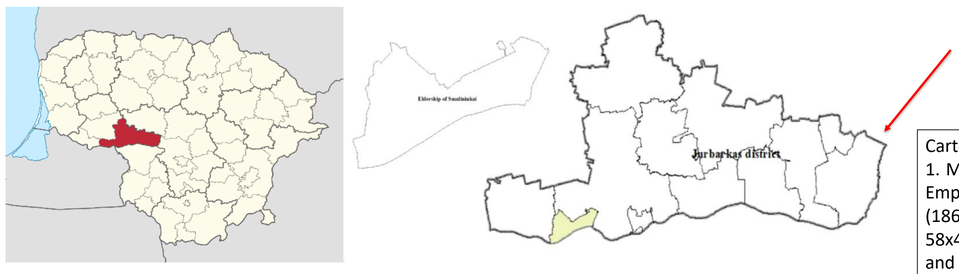

Figure 1. Geographical location of Jurbarkas District Municipality and Smalininkai Eldership

Cartographic maps used for the research:
1. Military topographical maps of the European part of the Russian Empire (Tsarist), compiled by the Military Topography Department (1860-1915). Scale 1:126 000. The map sheet is rectangular, 58x42cm, it corresponds to 73x53 km of terrain (Fig. 2 (a)), black and white.
2. Topographic maps of inter-war Lithuania, scale 1:100000 (1933-1940). The maps show the territory of the country at that time. The size of the map sheet is 47x45 cm (Fig. 2(b)), in colour.
3. Soviet topographic maps at a scale of 1:50000 (1988) (Fig. 2 (c)), in colour.
4. CORINE land cover database (2018). This is a vector dataset of 30 classes of land cover by type and land use.
5. LIDAR data (2009-2010) from the Lithuanian Spatial Information Portal

Figure 2. Maps: a) second half of the 19th century, b) first half of the 20th century, c) second half of the 20th century.

The area under non-forest cover was calculated:

$$S_{NM} = S_S - S_M$$

here: S_{NM} – non-forest area, S_S – eldership area, S_M – forest area.

Results

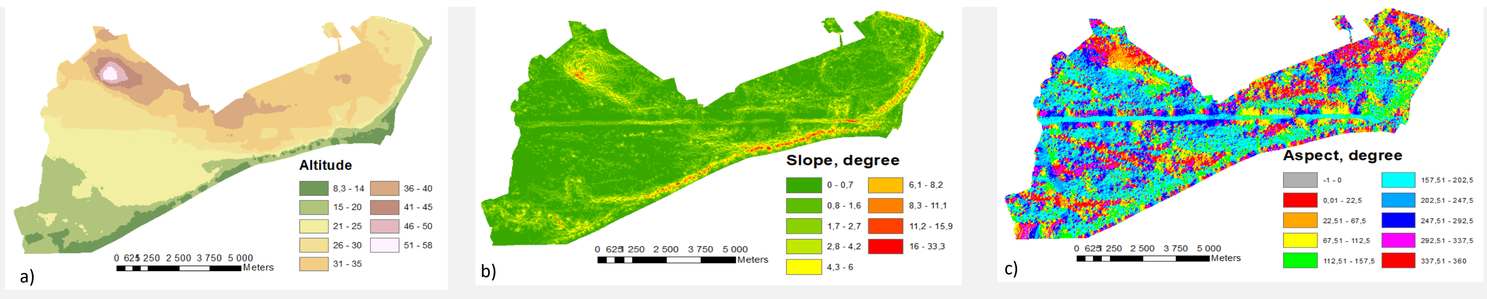

Figure 3: Geomorphological parameters of Smalininkai Eldership: a) Earth's surface height model, b) slope model, c) global slope model

Table 1. Forest cover and cultivated fields in Smalininkai Eldership

Year	Forest, %	Fields, %
1875	14,2	85,8
1938	22,4	77,6
1983	33,4	66,6
2018	39,3	60,7

Table 2. Some landscape elements in Smalininkai Eldership

Year	Length of rivers, m	Length of roads, m	Length of railway line, m	Water towers, pcs.
1875	37156,35	44576,02	9266,129	0
1938	27087,37	64977,26	9266,129	0
1983	61455,18	79791,87	0	16
2018	66310,45	92067,36	0	16

Table 3. Changes in forest cover and cultivated fields in different periods compared to the previous levels of the areas

Year	Period, in years	Change in agricultural land area, ha		Change in agricultural land area, %	
		Forest	Cultivated fields	Forest	Cultivated fields
1938/1875	63	216,5	-216,5	57,5	-9,5
1983/1938	45	291,2	-291,2	49,1	-14,2
2018/1983	35	155,3	-155,3	17,6	-8,8
2018/1875	143	663,0	-663,0	176,3	-29,2

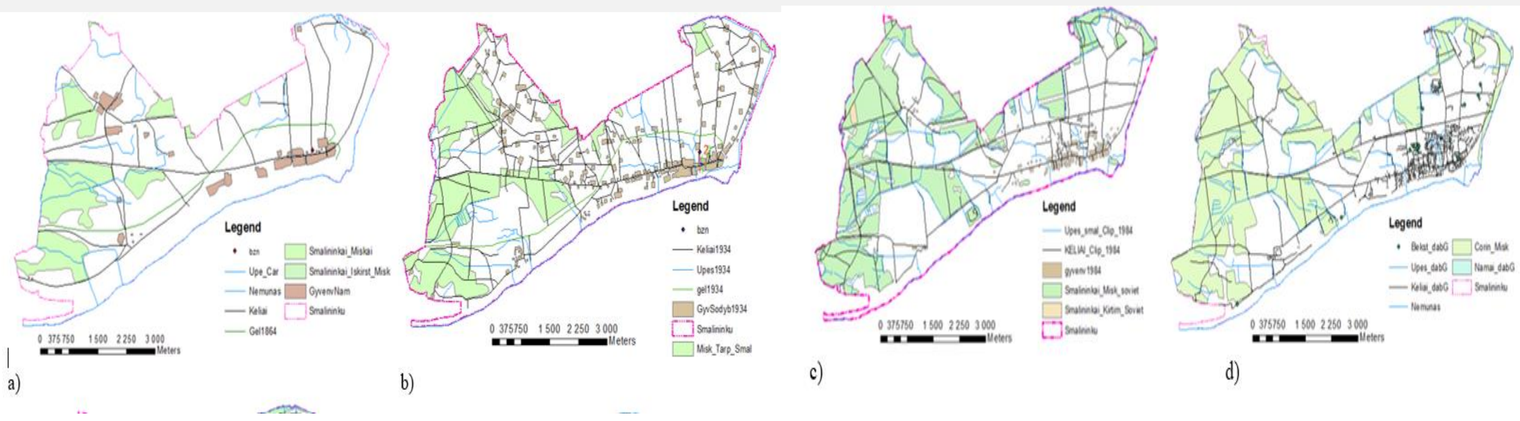

Figure 4. Maps of the landscape elements of Smalininkai Eldership: a) second half of the 20th century, b) first half of the 20th century, c) second half of the 20th century, d) first half of the 21st century.

Main conclusions

1. Smalininkai Eldership is characterised by favourable geomorphological conditions for agriculture and other activities. The elevation of the Earth's surface varies evenly from 15 to 40 m. A more pronounced elevation change (from 8 to 15 m) is observed only along the Nemunas River and (from 41 to 58 m) in the western part of the eldership, where the slopes range from 6 to 33 degrees. The orientation of the slopes in relation to the countries of the world is highest towards the south. As much as 50 % of the Earth's surface of the eldership is oriented in the south-eastern, southern and south-western direction. The favourable conditions for the development of agricultural activities have a significant influence on the landscape change. However, since the area has always been a border between two countries, the main source of income of the inhabitants has not been solely focused on agricultural activities.

2. During the period under study, the landscape of Smalininkai Eldership has undergone quite significant changes. In 1875, forests accounted for only 14.2 % of the eldership's area, while cultivated fields accounted for as much as 85.8 %. In 2018, the forest area had increased to 39.3 %, while cultivated fields had decreased to 60.7 %. There are no more landscape elements such as railway lines, but water towers have appeared since the second half of the 20th century. During the period under study, the agrarian landscape (cultivated fields) decreased, giving way to the natural landscape (forests).

VYTAUTAS MAGNUS UNIVERSITY AGRICULTURE ACADEMY

1924–2024 VMU Agriculture Academy