Quaternary International 386 (2015) 83–88

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Aspects and methods in reconstructing the medieval terrain and deposits in Vilnius

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ARTICLE INFO

Article history:
Available online 4 November 2014

Keywords:
Terrain
Landscape
Geophysic
Deposits
Reconstruction

ABSTRACT

The article deals with the geomorphological diversity (confluence of Neris and Vilnia rivers, junction of two ice ages, erosion hill terrains, terrace levels, etc.) of Vilnius city which played an important role in choosing the place for the city to be established and in formation of its defence structure. The diversity of terrain of Vilnius city and its environs is demonstrated by the distinguished morphogenetic zones: 20 morphogenetic units including 5 zones within the area of the medieval city. From the point of view of the history of environment, the historical relief of Vilnius city has five types of relief. The research was carried out in one of the five types of city topography: moraines left by glaciers (part of the Kuprijoniškės-Salininkai morainic complex). The shallow till acted as an impermeable barrier and created conditions for accumulation of groundwater. Springs emanated at the slope bottom turning into streams. The largest among them is the Vingrė River, which marks the boundary between two types of topography. The studied territory occupies 2.6 km^2. Through the reconstruction of the primordial terrain, it would be possible to trace the direction of Vingrė stream and the location of the defensive wall. LIDAR topography and borehole data, topographic maps of 1842 and 1994, and archaeological data were used. Geophysical and digital methods were applied. The research contributes to reconstruction of the pre-anthropogenic terrain, indicating possibilities for its optimal use and living conditions.

1. Introduction

Land topography is the totality of the vertical and horizontal dimensions (unevenness) of the land's surface as well as a systematic combination of shapes. It is one of the most stable components of inanimate nature and at the same time a geosystem distinguished by causative relationships and dynamics (Česnulevičius, 1998).

Settlements were usually established in watersheds, most of terrain being later altered. Representative investigations of urbanised terrain and anthropogenic deposit changes have been carried out by Popov (2007), Kotlov (1977), Lichačiova (2007) and Lichačiova et al. (1981). They present methods for reconstructing the original urban terrain and evaluating the degree of its change. Urban anthropogenic or 'fill-cultural' deposits have been investigated in many cities, reconstructions of the original terrain having been made in Cardiff, London, Paris, St. Petersburg, Odessa, Kiev, etc. In Moscow, fragments of the natural landscape have survived only in parks and squares. In Moscow, there are currently about 800 waterways, of which 115–140 are functioning rivers according to the author's work (Nasimovič, 1997), the remainder draining into underground collectors. The city of Vilnius also has channelled drainage.

Many research papers have addressed the three-dimensional aspect of historical cartography and focused on an image-based reconstruction and geometrical evaluation of one of the most remarkable landscape models in history, the topography of Franz Ludwig Pfyffer. Lieutenant General Franz Ludwig Pfyffer von Wyher (1716–1802) devoted 20 years of his life to constructing the topography of Central Switzerland (Niederoest, 2002). According to Fuse and Shimizu (2003, 2005), historical maps are precious materials, which show the spatial distribution of land use, streets, etc. that were of historical importance when the maps were created. They can be a dependable source of information for previous city planning concepts. The reconstruction of Tallinn's historical terraces made by Estonian archaeologists is comparable to the present authors' work in respect to methodology (Nurk et al., 2012, Kadak, 2013).

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http://dx.doi.org/10.1016/j.quaint.2014.09.068
1040-6182/

For the authors' research, the investigation of medieval terrain was a prerequisite in evaluating the role of natural landforms in the founding and expansion of Vilnius and the development of its transport system. The interpretations of historical sources have long been guided by political considerations, but the old city plans of Braun (1572), Getkant (1648), and von Fürstenhoff (1793) (Morkūnaitė et al., 2008, Morkūnaitė, 2010) were created using contemporary sources and lack precision. Geological geomorphological and geophysical investigations were used to determine the scale of the anthropogenic changes. The geomorphology and relief forming processes of Vilnius city (Morkūnaitė, 2010) has been described in detail by Dvareckas (1961), Vodzinskas (1963–1964), Basalykas and Dvareckas (1981), Gaigalas (1985–1986), Guobytė (2000, 2008), and others in recent decades.

The landscape of the Sapieginė hill terrain of the 14th century in front of the Gediminas Mount was described and evaluated from the point of view of city needs by Vaitkevičius and Kiškienė (2010), Vaitkevičius (2010). These authors made use of geomorphological methods. The primary relief of Vilnius Table Mount (Stalo Kalnas) was reconstructed using the complex *in situ* method and geophysical and geological investigations (Sarcevičius, 2011). The reconstruction of Vilnia valley palaeohydrology and the existence of a high saddle hill between the Gediminas and Three Crosses (Trijų Kryžių) mounts (at the time of formation of the high terraces) were described by Satkūnas (2012). Some researchers think that the impact of the geological and geomorphological processes that formed the topography of Vilnius cannot be compared to the degree of the anthropogenic changes (Šliaupa, 1999). The analysis of this degree presented here was designed to support or oppose this opinion.

Reconstructing the natural terrain helps to determine the influence of the natural heritage, i.e. the geological and geomorphological factors, on the development of Vilnius and the change in its hydrographical network. This reconstruction was made by eliminating the thickness of the anthropogenic layer from the absolute altitude. Stratigraphic diagrams and an evaluation of the city's geomorphological-lithogenic conditions were used for this. Landform reconstruction according to topographic map data is usually made using a computer program but also requires analytical methods.

The goal of the present research was to reconstruct the medieval terrain of the study site by eliminating the upper layer of anthropogenic deposits. The subgoals were to determine the possibilities for building roads, the directions of any transit roads, and the changes in the hydrographic network.

2. Study sites

The investigation was conducted in one of the city's five landscapes, morainic hills where groundwater accumulates on shallow till, an impermeable barrier (Fig. 1). The springs at the bottom of slopes are the sources of streams. The largest stream, Vingrė, divides the landscape into two terrains. It is important in the 2.6 km^2 study site to determine the changes in the original terrain and to evaluate its influence on the city's development. The selected landscape represents the city only partially, i.e. as a territory, where surface deposits cover moraine left by the second-to-last glaciation and where one of the main streams that supplied water to the inhabitants flowed on a scarp in Medieval and later times.

3. Sources and methods used in the topography reconstruction

Archival data was obtained from the Vilnius County Archives, historical data from the monographs and funds of the Lithuanian Institute of History, sample cores from the Lithuanian Geological Survey (LGS), data from the archaeological atlas of Vilnius, and data from a geo-scanner (geophysical measurements), gamma radiometer, etc. The following methods were used:

- an archival material analysis
- an analysis and survey of historical sources and of cartographic and visual material
- an analysis of geological boreholes and sections
- geophysical methods.

An archival material analysis was made to determine the development of the hydrographic objects in Vilnius and some of the problematic old areas of water use, especially springs, bogs, and streams and to check the geological borehole data on groundwater depth and impermeable layers. Maps and plans of springs in Vilnius were examined at the Vilnius County Archives. In order to reconstruct the change in natural conditions, borehole data from the Vilnius Geological Survey were analysed for the lithology of the various layers (especially surface layers) and the thickness of the upper (anthropogenic) layers down to the Medieval surface. In order to compile cartographic diagrams, the geological borehole data (depth, date, geographical coordinates, layer thicknesses) were digitised using computer programs and a database was created. The borehole sites were plotted on an orthophotographic basis.

The geomagnetometer Geo-Scanner BPT-3010 was used to measure the average and extreme values of the magnetic field. Under field conditions, the device determines the magnetic field values in 20 linear points, saves the values to memory, and with the

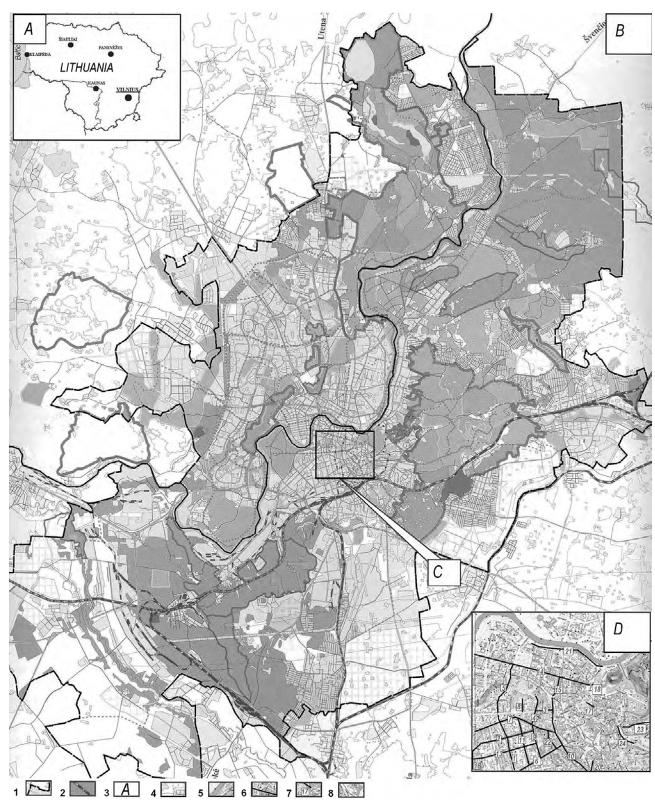

Fig. 1. Main scheme (1. *Vilnius city limits*; 2. *Railways*; 3. *Insets* (Location of Vilnius in SE Lithuania (A); map of Vilnius (B); location of the reference data discussed in the text (C); 4. *Suburban areas*; 5. River Neris; 6. *Streets mentioned in the article (D) Inset*; 7. The streets named: (1. Švitrigailos; 2. Vivulskio; 3. Kalinausko; 4. Tauro; 5. Kudirkos; 6. Naugarduko; 7. Basanavičiaus; 8. Valančiaus; 9. Mindaugo; 10. Pylimo; 11. Algirdo; 12. Sierakausko; 13. Ševčenkos; 14. Gedimino; 15. Jogailos; 16. Smolensko; 17. Daukanto; 18. Cathedral Square; 19. Vilniaus; 20. Bazilijonų; 21. Žygimantų; 22. Vingrių; 23. Užupio; 24. Malūnų.) 8. *Vilnius Region*).