Barometr Regionalny
Tom 16 nr 3

# Using Airborne Laser Scanning Data to Assess the State Historical Garden Complexes

**Anna Dudzińska, Barbara Szpakowska**
Poznań University of Life Sciences, Poland

**Abstract**

*The aim of the study was to assess the possibility of applying GIS analysis for investigations into the state of preservation of a baroque garden complex. The article presents a method based on Airborne Laser Scanning data (LIDAR) which can be used for analysis of revalorization of historical garden complexes. The research was conducted in a rural park in Siemczyno, Zachodniopomorskie Voivodship, Poland. The analysis was made by means of the ENVI and ArcMap programs. The article presents an analysis of the terrain microstructure, which was used for assessment of changes in the terrain. It is a significant element used for planning public space. The research results were compared with the park inventory data of 1973. The research proved that LIDAR data analysis could be used for assessment of the state of preservation of historical garden complexes. It might also be used for preparation of park registration documentation or revalorization plans.*

**Keywords:** GIS analysis, historical parks, Siemczyno, Poland

**JEL:** Q24, R14

## Introduction

Palace and park complexes are important natural and cultural assets. These natural systems play a significant role in the environment because they are valuable fauna and flora habitats. They are also places of leisure and recreation for the inhabitants of areas with palace and park complexes because they are elements of public green space. These complexes are often related with history and reflect the region's identity. At present many historical green space forms which used to belong to illustrious families are neglected due to unregulated property rights, lack of care or funds. In consequence, tree stands in these complexes are often defective, vegetation grows spontaneously, and buildings fall into ruin.

## 1 Palace and park complexes in Poland — outline of history

The geometric style, which dates back to medieval gardens established near monasteries, was the first type of man-created green space. Monastery gardens had simple forms. They were divided into quarters and were chiefly used as crop gardens. In the center there was a sculpture or a water element. The form and character of renaissance gardens was similar. They were divided into quarters, where crops were grown. They were edged by espaliers of bushes or accentuated with topiaries. Later they became more complex and the decorative function replaced the utility character of gardens (Bogdanowski, Łuczyńska-Bruzda, and Novák 1981).

**E-mail addresses of the authors**
Anna Dudzińska: anna.dudzinska@up.poznan.pl
Barbara Szpakowska: barbara.szpakowska@up.poznan.pl

In the 15th and 16th centuries baroque gardens began to appear in Polish horticultural art. In the beginning they were simple and influenced by the previous epoch. Later they became more ornamental. Baroque gardens had elements which distinguished them from gardens from other epochs. The main compositional axis marked the most important alley. It was also accentuated with topiaries. Baroque gardens were characterized by a regular arrangement: an entrance courtyard, palace and a garden with the most important interior, a so-called garden salon. Water elements were also important — there were canals, cascades, pools, fountains and water traps. Later baroque gardens became more decorative and path systems became more complicated.

After the period of geometrical gardens, artists of the neoclassicism period loved to see nature as it was. At that time mansion and garden complexes were based on the beauty of nature in its irregular forms. The scenic trend in horticulture was inspired by landscapes accentuating the picturesqueness of nature. The innovative character of scenic solutions was manifested by natural forms of plants and winding roads (Bogdanowski, Łuczyńska-Bruzda, and Novák 1981; Ciołek 1978; Majdecki 2008a, 2008b). The development of naturalist gardens coincided with the emergence of new trends (i.e., sentimentalism, neoclassicism, and romanticism). Naturalist gardens were mostly composed of deciduous trees as well as coniferous trees, blooming shrubs and perennials. Fascination with travel and exoticism resulted in the appearance of foreign species in gardens. Different types of tree arrangements were important spatial elements in scenic gardens. There were both groups of several trees arranged in a lawn as well as woods or picturesque groves. In the 19th century horizontal planes were irregularly outlined in gardens, which were characterized by free composition. We can observe a similar style in the palace and park complex in Siemczyno near Drahim Castle land, which is discussed in this article.

## 2 Research area

The research was conducted in a rural park in Siemczyno, Commune of Czaplinek, Zachodniopomorskie Voivodship, Poland. This area is characterized by numerous natural and cultural values, which make it more attractive to tourists. The park in Siemczyno was established as a baroque complex in the 18th century. The stately palace was built on a horseshoe plan. It was inspired by French manorial buildings. The composition was aligned axially and it included the following characteristic elements: a long driveway leading to the entrance gate with sculptures of two knights, a forecourt surrounded by outbuildings, a ceremonial courtyard (cour d'honneur) in front of the palace façade, the palace and a vast regular garden (Leszczełowski 2013). At the end of the 18th century the palace was extended with a south wing, a tower, a conspicuous entrance gate and grange buildings. In 1907 an asymmetrical north wing was built.

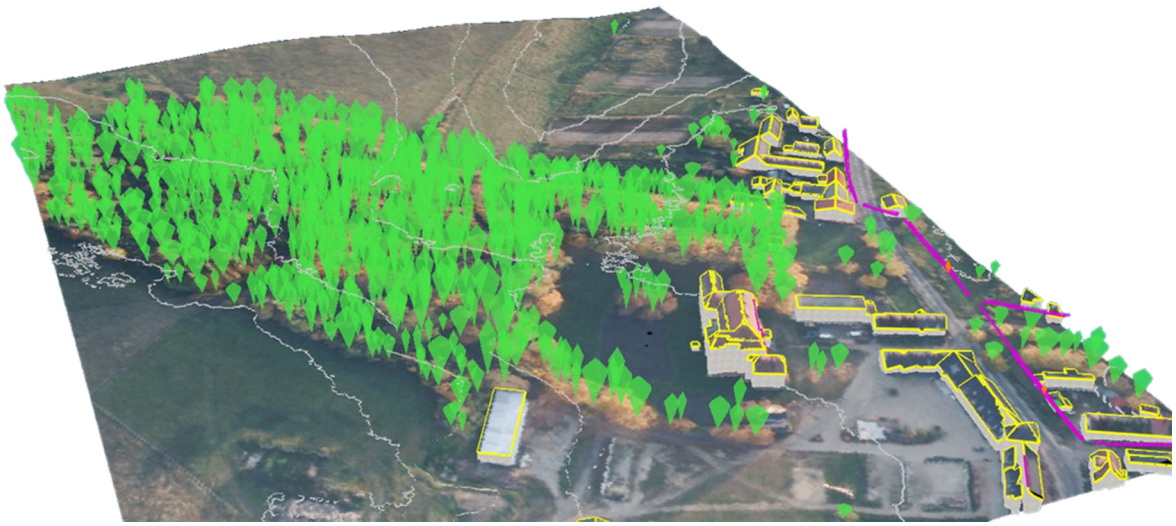

**Fig. 1.** An image of the park in Siemczyno

The palace garden established in the 18th century stretched in an area of more than 3 hectares. The composition was dominated by formed hornbeam (*Carpinus betulus*) alleys, which led to the palace. The axial baroque garden in Siemczyno underwent numerous changes in the 19th century, when its new owners transformed it into a scenic composition. New tree species appeared. Apart from hornbeam-trees, there were numerous oak-trees (*Quercus robur*), lime-trees (*Tilia cordata*), maple-trees (*Acer platanoides*), spruce-trees (*Picea abies*) and beech-trees (*Fagus sylvatica*). There is a small forest complex adjacent to the southern part of the original garden. Probably it was part of the composition. There may have been a small menagerie in that place. The spatial composition of the park also included ponds, which were connected to the nearby lake by a ditch. According to the park inventory conducted in 1973, there was a garden salon with a rectangular pond, a garden cabinet, an alley, espalier and bowling green.

## 3 Aim of study

The aim of the study was to assess the state of preservation of the baroque garden complex, using GIS analysis. The article presents a method which can be used for analysis of revalorization of historical garden complexes. The research results were compared with the park inventory data of 1973.

## 4 Methodology

The research was based on the methodology combining history and geography (i.e., geohistory). Analyses were based on a Historical Geographic Information System (HIGS), which uses maps as a basic source of information, whereas analyses are conducted with specialized GIS software (Affek 2012; Challis 2006; Dudzińska, Szpakowska, and Szumigała 2016; Gregory and Ell 2007; Nita and Myga-Piątek 2012; Rieg et al. 2014; Van Eetvelde and Antrop 2009).

The investigations were based on raster analysis (spatial analyses). According to Gregory and Ell (2007), the choice of raster or vector analysis chiefly depends on data availability and on the object analyzed. Raster data are better for presentation of whole surfaces, whereas vector data are better for analyzing points or strictly defined areas. The research material in the LAS file format was acquired from the Chief Geodesic and Cartographic Documentation Centre. Next, a digital elevation model (DEM) was prepared by means of the ENVI Feature Extraction Module. The model was used as the input data for historical analysis of the terrain. An orthophotomap was also prepared. The research involved analysis of the terrain microstructure, which was used in an attempt to identify the remains of the baroque garden complex. The results were compared with an early 20th-century Prussian map.

The Prussian map (from the year 1929) was digitized in the edit mode of the ArcGIS program. It involved rubbersheeting transformation—flexible matching, which consisted in local smoothing of polynomials and simultaneous maintenance of the continuity of control points (Urbański 2012). Spline transformation results in the total root-mean-square error (RMSE) of 0,00 m. However, the method causes considerable deformations of the map itself. The calibration accuracy decreases with distance from adjustment points (Jaskulski, Łukasiewicz, and Nalej 2013). Therefore, 25 control points were selected for the research. The visual deformation of the map did not have significant influence on the results.

## 5 Results

The first stage of the research involved analysis of the Digital Elevation Model (DEM) prepared from LIDAR data (LAS file). Regular lines which might point to the existence of the baroque garden complex were inventoried from changes in the terrain microstructure. The data were overlaid on the Prussian map (fig. 2). The comparison showed that these elements matched the regular layout of the park shown in the early 20th-century map. It means that these elements were remains of the original complex. The measurement of distances between the lines showed that their lengths were identical (59 m).

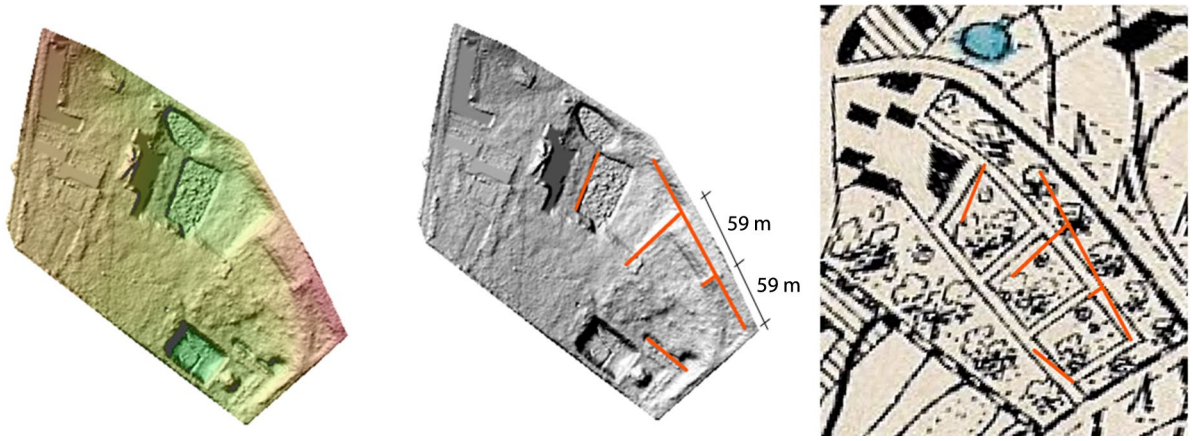


**Fig. 2.** Analysis of the terrain microstructure to identify remains of the baroque garden complex: Siemczyno park microstructure (left); Inventory of the regular remains of the baroque garden complex (center); Results vs. the Prussian map (right)

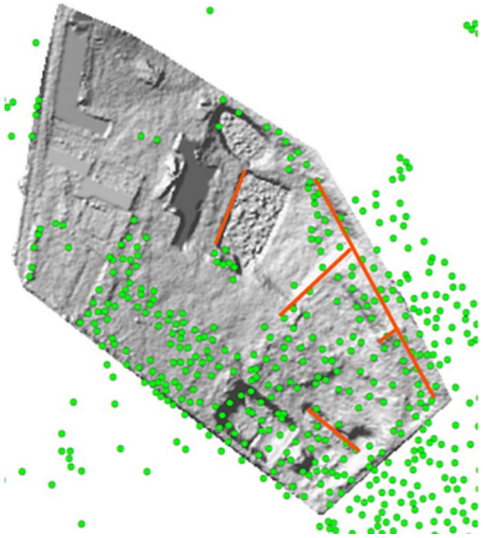

**Fig. 3.** Inventory of tall vegetation in the park

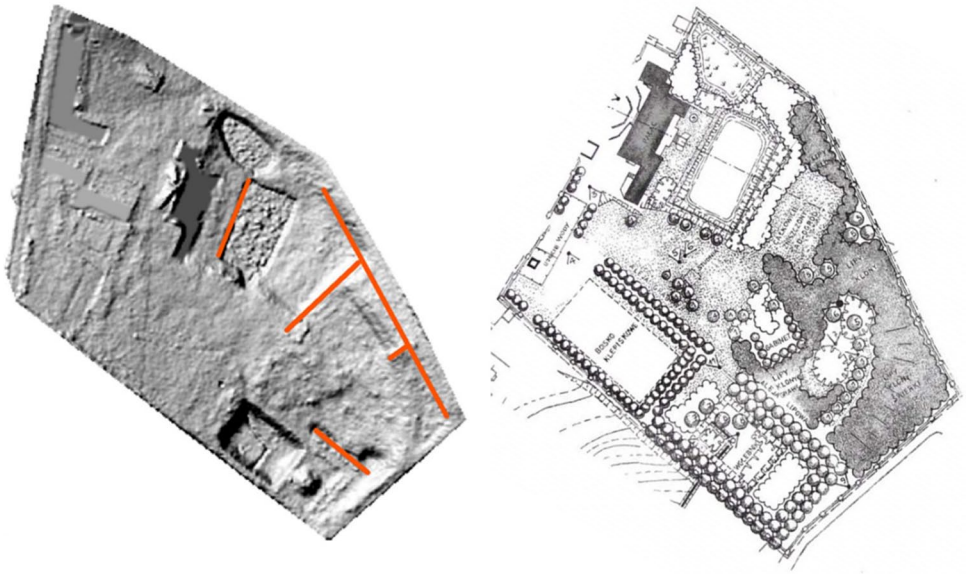

**Fig. 4.** The analysis of the terrain microstructure vs the inventory made during the park registration (1973): Analysis of the microstructure with remains of the baroque composition (left); Park inventory of 1973 (right)

The lines in the image are directly related with the presence of tall vegetation (fig. 3). Trees were planted along longitudinal lines bordering the complex. The garden was divided into three quarters. There was a parterre in the first quarter. At present there is a waterbody there. The scenic axes of the historical garden complex have been preserved. There is tall vegetation in the other two quarters.

The research results were compared with the inventory made in 1973 when the park was prepared for registration. The comparison of the analysis of the terrain microstructure and inventory (fig. 4) shows that in 1973 the original baroque composition was not clearly noticeable. Lime-tree alleys ran along the lines identified in the analysis of the terrain microstructure. They were related with the historical composition. It is most likely that the hornbeam espaliers, which can be seen in the inventory, were not part of the original baroque complex. They appeared at a later period.

The analysis of the terrain microstructure enabled identification of a depression stretching from the pond towards a depression, or the bowling green, as it was named in the park registration document (fig. 5). It shows that there was a watercourse which was connected to a ditch outside the park. It is most likely that the hollow did not originate in baroque times. It appeared later and was used as a temporary body of water. It was part of the designed irrigation system. Its rectangular shape resulted from inscribing this object in the regular garden complex.

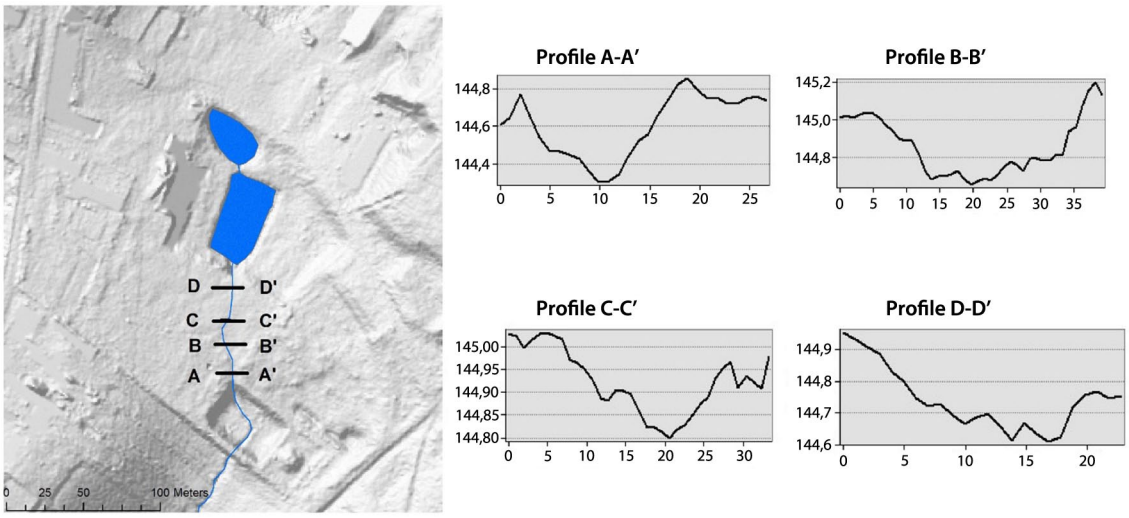


**Fig. 5.** The analysis of the terrain microstructure between the pond and a depression, or the bowling green, as it was named in the park registration document

## Conclusion

Rural parks are important natural and cultural elements creating the landscape. They are valuable sources of information about history of a particular region and they are important fauna and flora habitats. Rural parks are often called post-manorial parks because they were established near mansions as well as in palace and park complexes. They are good examples of cooperation between designers and gardeners and their skills in space arrangement. Unfortunately, these places have often been degraded and devastated in recent times. Therefore, it is important to search for a precise method enabling assessment of the state of preservation of these garden complexes so that they can be revalorized.

The article describes the methodology which can be used for assessment of the state of preservation of historical garden complexes and it presents a case study of the park in Siemczyno. LIDAR data can be used for analysis of the terrain microstructure. They show changes in the terrain, which is an important element used for creation of baroque gardens. The data enable identification of the location of roads, waterbodies, watercourses and in this case a baroque bowling green. The data can be used as input material for preparation of park registration documents and designs of revalorization of historical garden complexes.

## References


Affek, A. 2012. "Kalibracja map historycznych z zastosowaniem GIS." *Prace Komisji Krajobrazu Kulturowego PTG* (16): 48–62.

Bogdanowski, J., M. Łuczyńska-Bruzda, and Z. Novák. 1981. *Architektura krajobrazu.* 3rd ed. Warszawa-Kraków: Państwowe Wydawnictwo Naukowe.

Challis, K. 2006. "Airborne Laser Altimetry in Alleviated Landscape." *Archeological Prospection* (13): 103–127.

Ciołek, G. 1978. *Ogrody polskie.* 2nd ed. Warszawa: "Arkady."

Dudzińska, A., B. Szpakowska, and P. Szumigała. 2016. "Ocena zmian krajobrazu wsi Napachanie (woj. wielkopolskie) za pomocą analizy historycznej GIS." *Nauka Przyroda Technologie* 10 (3): 1–8. doi: 10.17306/J.NPT.2016.3.31.

Gregory, I., and P.S. Ell. 2007. *Historical GIS. Technologies, Methodologies, and Scholarship.* Cambridge: Cambridge University Press.

Jaskulski, M., G. Łukasiewicz, and M. Nalej. 2013. "Porównanie metod transformacji map historycznych." *Roczniki Geomatyki* 11 (4): 41–57.

Leszczełowski, J. 2013. "Rozważania o początkach wsi Heinrichsdorf." In *Zeszyty Siemczyńsko-Henrykowskie. Tom 2*, edited by B. Andziak. Siemczyno: Zakład Usługowy "Tempoprint" Teresa Polak.

Majdecki, L. 2008a. *Historia ogrodów. Tom 1, Od starożytności po barok.* 3rd ed. Warszawa: Wydawnictwo Naukowe PWN.

———. 2008b. *Historia ogrodów. Tom 2, Od XVIII wieku do współczesności.* 3rd ed. Warszawa: Wydawnictwo Naukowe PWN.

Nita, J., and U. Myga-Piątek. 2012. "Rola GIS w ocenie historycznych opracowań kartograficznych na przykładzie Wyżyny Częstochowskiej." *Prace Komisji Krajobrazu Kulturowego PTG* (16): 116–135.

Rieg, L., V. Wichmann, M. Rutzinger, R. Sailer, T. Geist, and J. Stotter. 2014. "Data Infrastructure for Multitemporal Airborne LiDAR Point Cloud Analysis—Examples from Physical Geography in High Mountain Environments." *Computers Environment and Urban Systems* 45: 137–146. doi: 10.1016/j.compenvurbsys.2013.11.004.

Urbański, J. 2012. "GIS w badaniach przyrodniczych." In. ocean.ug.edu.pl: Uniwersytet Gdański. http://ocean.ug.edu.pl/~oceju/CentrumGIS/dane/GIS_w_badaniach_przyrodniczych_12_2.pdf.

Van Eetvelde, V., and M. Antrop. 2009. "Indicators for Assessing Changing Landscape Character of Cultural Landscapes in Flanders (Belgium)." *Land Use Policy* 26 (4): 901–910. doi: 10.1016/j.landusepol.2008.11.001.

Żarska, B. 2003. *Ochrona krajobrazu.* 2nd ed. Warszawa: Wydawnictwo SGGW.