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THE TOURISM ATTRACTIVENESS OF LANDFORMS IN ŁAGIEWNICKI FOREST, ŁÓDŹ

Abstract: The article is an attempt to present the attractiveness of the recreational area of Łagiewnicki Forest in Łódź as regards the diversity of its relief. The work is based on an analysis of digital elevation models, using GIS techniques and direct observations. Based on an analysis of the relief, the authors have proposed a new tourism trail focused on the 'morphometric assets' of the area.

Keywords: Łagiewnicki Forest, GIS analyses, digital elevation model, terrain profiles.

1. INTRODUCTION

Sensing a landscape is a subjective experience; a mountainous landscape will be sensed differently by local inhabitants compared to those living in lowland areas. The Łódź region is mostly located in the old glacial landscape zone where as a rule one can expect poorly diversified terrain. A certain diversity of landscape can be observed in the 'edge' zone of the Łódź Hills (*Wzniesień Łódzkich*) where ice sheet processes, deposition and later erosion, has resulted in a relatively varied relief, considering it is in the Polish Lowlands. In the past, the area of today's Łódź region was covered by the Łódź Forest. The development of the settlement system and agriculture quickly led to the destruction of that forest and only small parts have survived until the present day. One of them is Łagiewnicki Forest – a natural complex which has remained nearly intact as oak-hornbeam and oak woodland. It is situated in the northern part of Łódź and many sources refer to it as the largest forested area within the administrative borders of any city in Europe (Fig. 1). It is obvious that its location has made the forest a recreational area for the inhabitants of

Łódź. Tourism in Łagiewnicki Forest includes both one-day and longer stays (HAŁKA 1994): longer stays concentrate mainly around the ponds in Arturówek with recreational facilities, while 'one-day tourism' involves walking through the forest along paths and marked trails, nordic walking, mountain biking and horse riding. Łagiewnicki Forest has also become a research area for Łódź academics. Most frequently, publications present the results of botanical, ornithological, wildlife and tourism research. The authors of this article, who know the area quite well as they have been leading field classes there with students for many years (as well as their own research and observations) decided to present one element of the Łagiewnicki Forest natural environment – its relief – with respect to its landscape and tourism attractiveness. In order to do that, they used GIS tools. The authors believe that this particular issue is rarely discussed in the literature with reference to this area and may be a significant element of its promotion if we consider the location of Łódź in the Polish Lowland zone.

2. RESEARCH METHODS

In their study, the authors used a numerical model achieved by digitalizing the contour lines of topographic maps at a scale of 1:10 000. The interpolation of elevation data was done using Golden Software Surfer 12, obtaining a digital elevation model with a grid cell interval of 10 m. Next, based on GRID in the ESRI ArcGIS 10.2 program, maps were drawn showing the slope angles (EWERTOWSKI & TOMCZYK 2007, URBAŃSKI 2008, TOMCZYK & EWERTOWSKI 2009). Topographic profiles along the trails were also prepared in order to calculate and then compare the basic morphometric parameters. The final cartographic work was done using ESRI ArcGIS 10.2 and Corel X5 programs.

3. THE PALEOGEOGRAPHY OF THE RESEARCH AREA

In December 1996, Łagiewnicki Forest became a part of the Łódź Hills Landscape Park (*Park Krajobrazowy Wzniesień Łódzkich*) which was being created at that time. The major geographical assets for which the park was created included a varied geological structure and, consequently, an extremely diversified relief for this part of Poland (KLAJNERT 1998). The area of particular concentration of these assets lies in the western part of the park i.e. Łagiewnicki Forest. In the Quaternary, this area was repeatedly covered by Scandinavian ice sheets which deposited material transported over long distances including moraine formations from earlier glaciations. Local material from the geological bedrock formations – Mesozoic, Paleogene and Neogene – is also found.

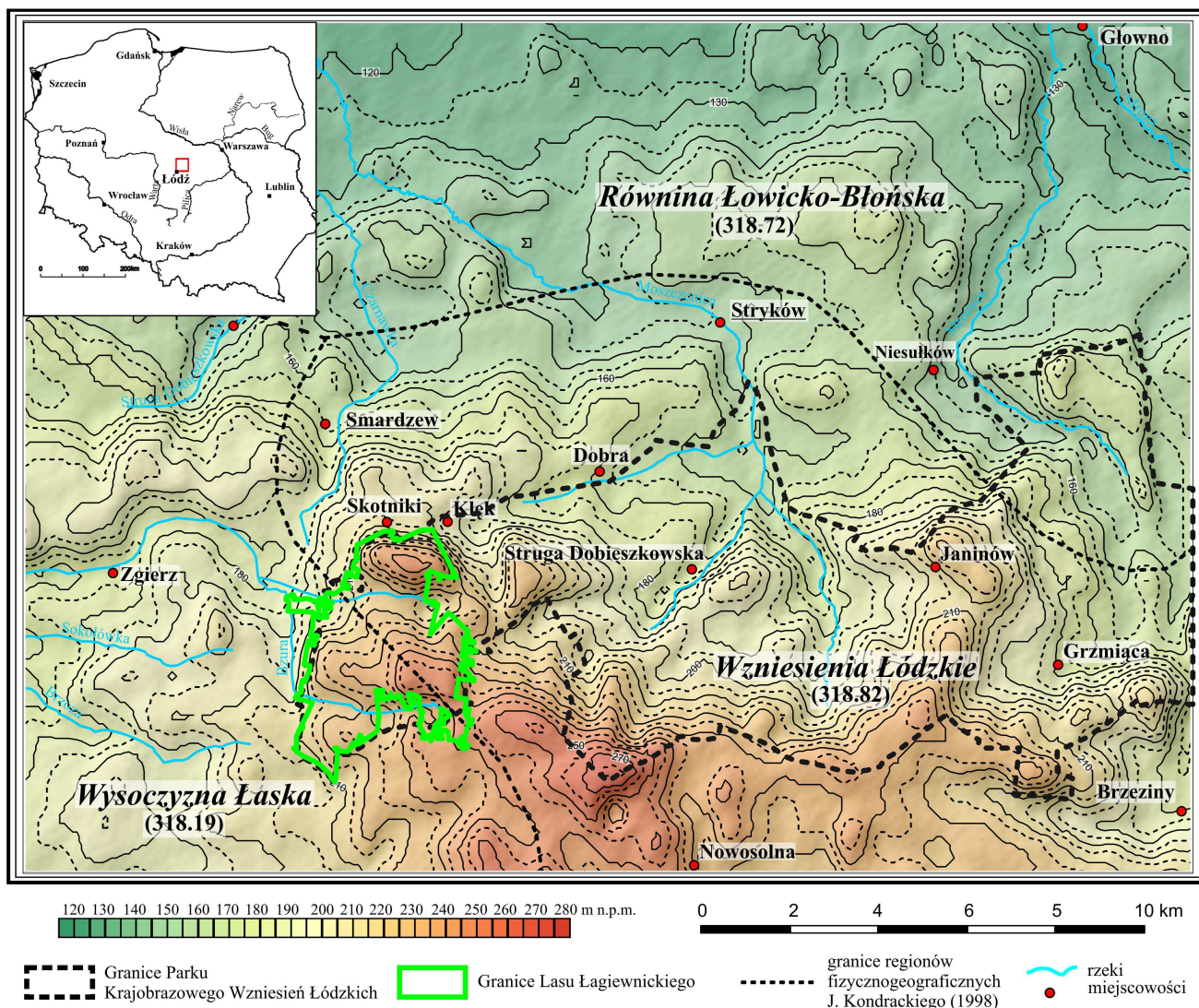


Fig. 1. The location of Łagiewnicki Forest in the Łódź Hills Landscape Park (*Park Krajobrazowy Wzniesień Łódzkich*)

Source: authors, based on the CODGiK Digital Elevation Model with a grid cell interval of at least 100 m

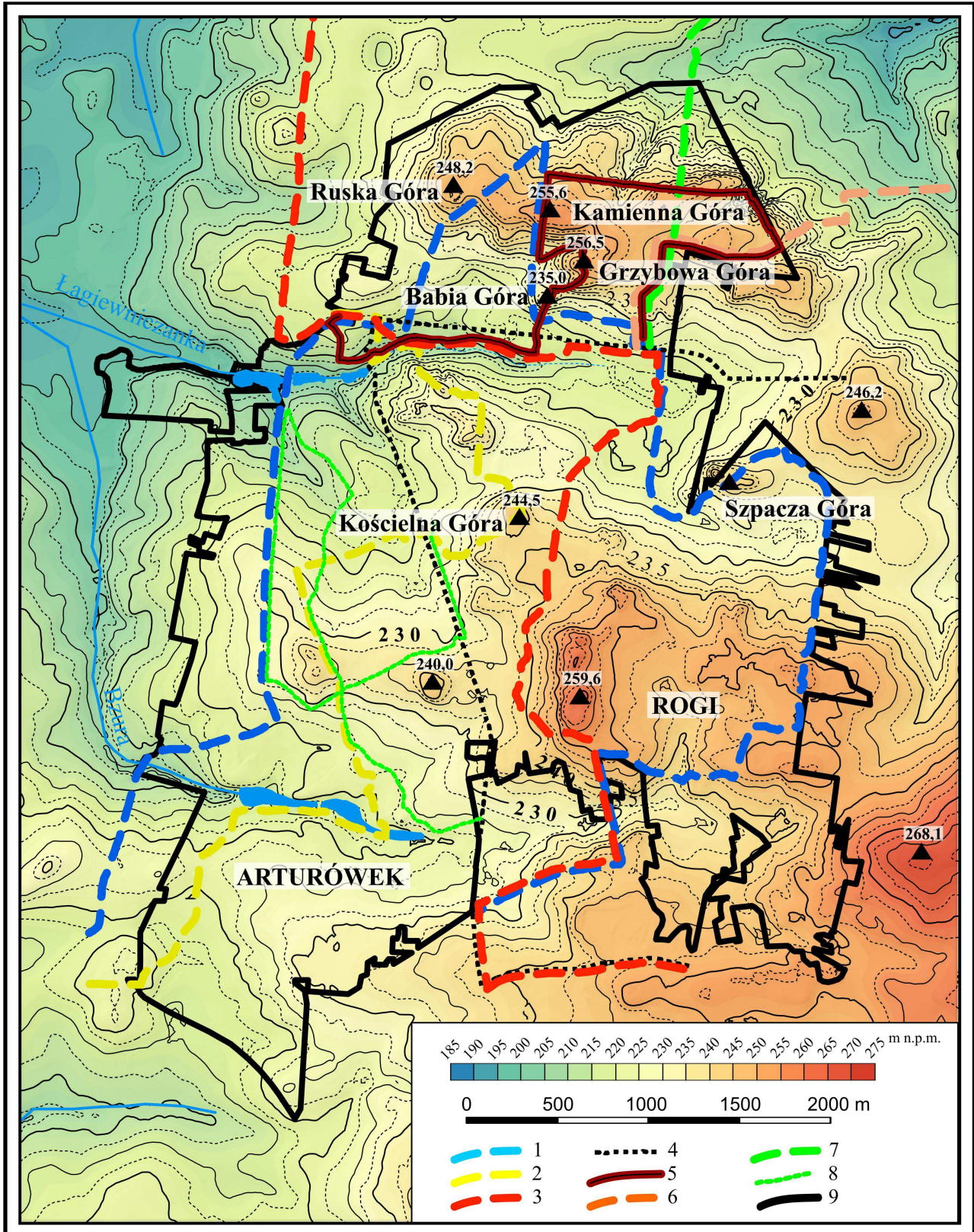


Fig. 2. Tourism trails in Łagiewnicki Forest in Łódź in the context of relief

- 1 – Łagiewnicki Forest blue trail, 2 – Łagiewnicki Forest yellow trail, 3 – Red trail – Łódź, 4 – Łódź Hills Landscape Park black trail, 5 – the trail suggested by the authors, 6 – Łódź Horse Riding Trail, 7 – Łódź Hills Landscape Park green trail, 8 – Łagiewnicki Forest Nature Path, 9 – Łagiewnicki Forest boundaries

Source: authors based on CMW CODGiK

The deciding factor as regards the relief of this area was the ice sheet of the Warta glaciation which before melting covered the whole area over the period from 195 000 to 128 000 years ago (LINDNER 1992). The Mesozoic rock threshold between Zgierz and Brzeziny was the cause of heavy deposition by the ice sheet which squeezed, pushed and elevated enormous masses of material to form varied morainic hills. As a result of this process, Łagiewnicki Forest is an area where the Quaternary deposits are thickest in the neighbourhood of Łódź (more than 100 m). These higher elevations often occur alongside depressions, due to the erosive lowering of the bedrock by the ice sheet, as well as the activity of water from the melting glacier and subsequent erosion. Such a relief formation mechanism is the main cause of its great diversity. In the literature, the zone is referred to as the northern edge of the Łódź Upland (*Wyżyna Łódzka* – DYLIKOWA 1973) or the Łódź Hills (*Krawędź Wzniesień Łódzkich* – KONDRACKI 1998). To the north of the highest sections of the Łódź Hills, beyond the city borders, it slopes down towards the Warsaw-Berlin *Urstromtal* (KLATKOWA 1965, 1972, SZMIDT & JASKULSKI 2012, SZMIDT 2013).

According to the morphological division of Łódź, established by J. GOŹDZIK & J. WIECZORKOWSKA (2002), Łagiewnicki Forest belongs to Łagiewnickie Hills (*Wzgórza Łagiewnickie*).



Photo 1. A part of the Bzura valley below the ponds in Arturówek
Photo: A. Szmidt

One look at the contour map confirms that we are dealing with an area of extremely varied relief (Fig. 2). The highest elevation of Łagiewnicki Forest is 259.6 m above sea level at Rogi, east of the junction of Wycieczkowa and Mleczna Sts where vertical differences in height exceed 20 m. Another interesting area is the north-eastern part of the forest culminating in Ruska Góra at 248.2 m, height differences exceed

30 m and slope angles are greater than 10°. The central area is also high and steep while to the south, on the other side of the Łagiewniczanka valley, there is a complex of landforms produced from tills, gravels and sands (BIERUT-MORDYLAK 2005). To the north-west of the village of Moskule, there are some small-scale dunes – aeolian landforms. Within the forest itself, there are two river valleys: the Bzura and, in the northern part, the Łagiewniczanka. These streams formed valleys with relatively steep sides, cut with numerous small valleys, gullies and depressions.

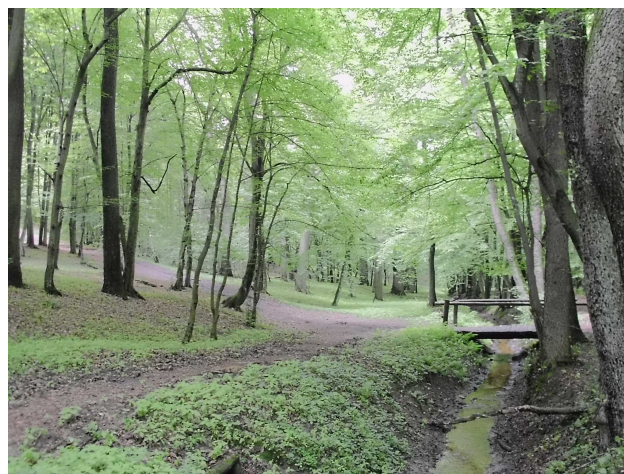


Photo 2. A part of the Łagiewniczanka valley above the chapels in Łagiewniki
Photo: A. Szmidt

In some places, the relief is varied, with steep slopes of up to 30° characteristic of upland areas. Some parts of the valleys have been considerably transformed anthropogenically by engineering some sections of the stream channels. In the 19th and 20th c., several ponds were created in these valleys which make an additional attraction of the area.

4. MORPHOMETRIC ANALYSIS OF THE TOURISM TRAILS IN ŁAGIEWNICKI FOREST

In the area of Łagiewnicki Forest, there are several trails and a number of educational and jogging paths, usually using the old road system, in addition to numerous interesting sites. Geomorphologically attractive elements include the moraine hills with the greatest vertical height differences. However, looking at the course of the trails on the contour map, as well as the slopes, it can be seen that the potential of Łagiewnicki Forest in this respect seems to be under-used (Figs 2, 3, 4). The most attractive and the longest is the blue trail.

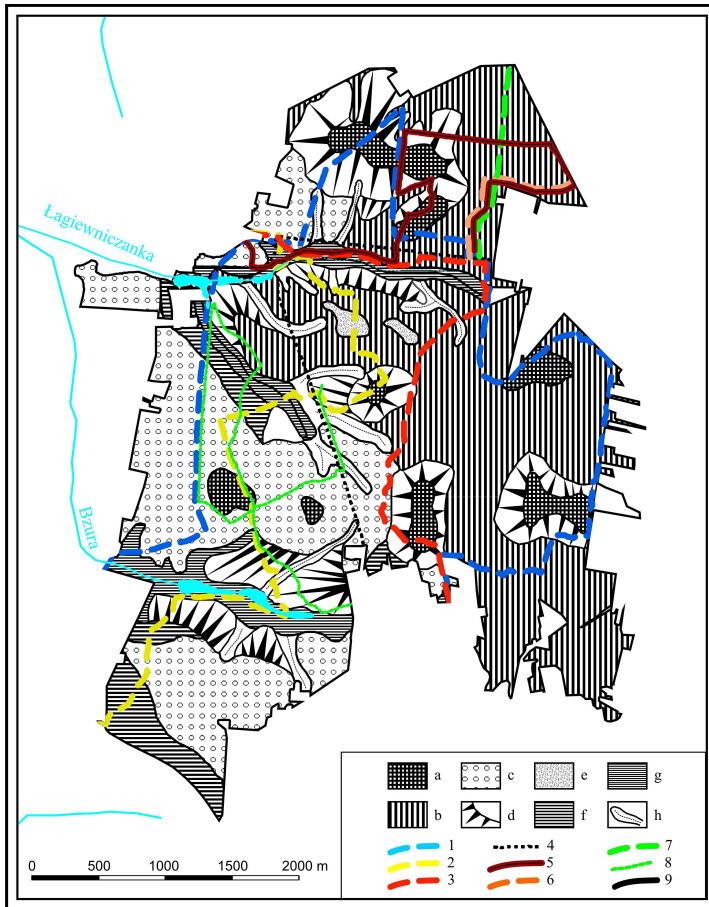


Fig. 3. Tourism trails in Łagiewnicki Forest overlying a geomorphological map of the area (according to BIERUT-MORDYLAK 2005)

- a - moraine hills,
 - b - moraine upland,
 - c - outwash plains and fluvio-glacial deposits,
 - d - slopes,
 - e - dunes,
 - f - fluvial terraces,
 - g - floodplains,
 - h - small valleys, gullies and recent erosional features
- Numerical marking as in Fig. 2

Source: authors based on A. BIERUT-MORDYLAK (2005)

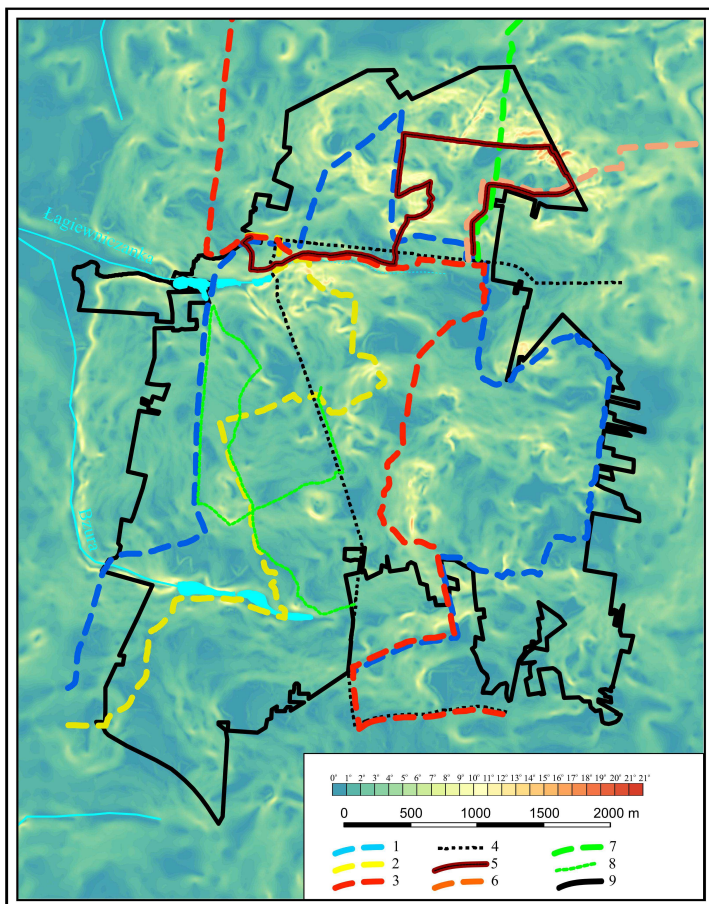


Fig. 4. Relief map of the area of Łagiewnicki Forest
Numerical marking as in Fig. 2

Source: authors

The blue trail is 14.3 km long and offers ascents totalling 191 m and descents of 182 m, which gives a mean of 26 m per km of height difference along the trail (Fig. 5, Table 1). The trail begins in Łagiewnicka St, crosses the Bzura valley below the ponds in Arturówek and runs to the north towards the monastery in Łagiewniki (Fig. 2). Over this four-km distance, the slope of the trail generally does not exceed 2°. The most interesting part runs across the northern part of the forest, e.g. crossing Ruska Góra, 248.2 m where there are differences of up to 36 m in height. Unfortunately, further on, the trail avoids the major elevations of the research area.

The yellow trail in Łagiewnicki Forest is much shorter at 7.5 km (Fig. 6, Table 2). It also starts at Łagiewnicka St, but then runs beside the ponds in Arturówek and then northwards to the hospital in Łagiewniki. Its main aim is to preset the Łagiewnicki Forest Reserve and the Bzura and Leśniczanka valleys. On this trail, there are 85.8 m of ascents and 89.6 m of descents which give a mean height difference of 23.3 m/km.

Łagiewnicki Forest is also where a part of the red Łódź trail runs, 6.2 km in length with ascents of 73.5 m and descents of 100.7 m (Fig. 7, Table 3). The mean height difference per km is 21.3 m. The trail starts near Kryształowa St and runs northwards avoiding the main elevations. In terms of relief, a relatively attractive section runs along the Łagiewniczanka valley towards the chapels in Łagiewniki.

Table 1. Basic morphometric statistics for the blue trail in Łagiewnicki Forest

	Total (m)	Total length of trail sections (m)
Ascents	190.7	7,762.6
Descents	182.2	6,514.8
Total	372.9	14,277.4

Mean height difference: 26.1 m/km.

Table 2. Basic morphometric statistics for the yellow trail in Łagiewnicki Forest

	Total (m)	Total length of trail sections (m)
Ascents	85.8	4,338.4
Descents	89.6	3,187.5
Total	175.4	7,525.9

Mean height difference: 23.3 m/km.

Table 3. Basic morphometric statistics for the red trail in Łagiewnicki Forest

	Total (m)	Total length of trail sections (m)
Ascents	73.6	2,858.5
Descents	100.7	5,340.1
Total	174.3	8,198.6

Mean height difference: 21.3 m/km.

Source: authors.

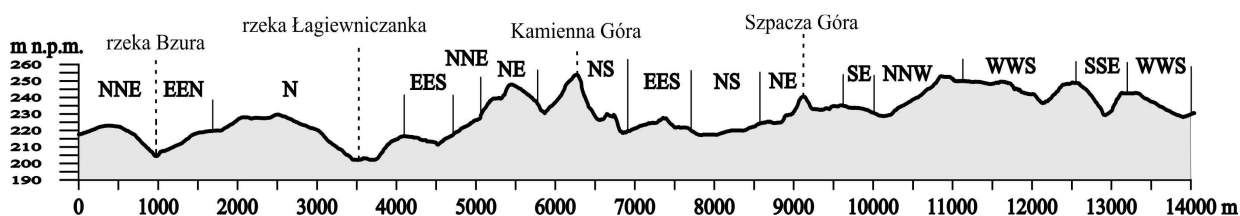


Fig. 5. Terrain profile along the blue trail

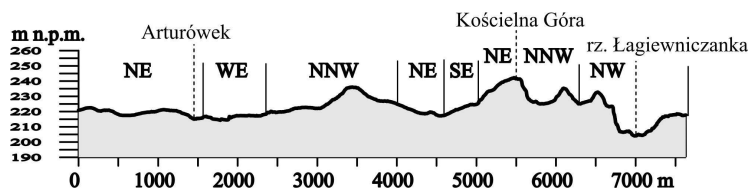


Fig. 6. Terrain profile along the yellow trail

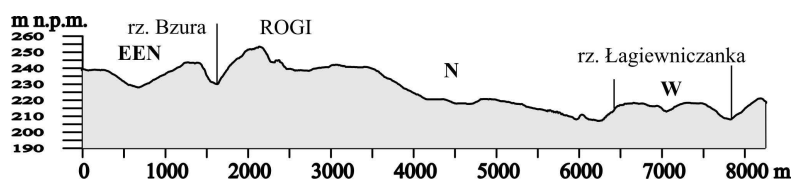


Fig. 7. Terrain profile along the red trail

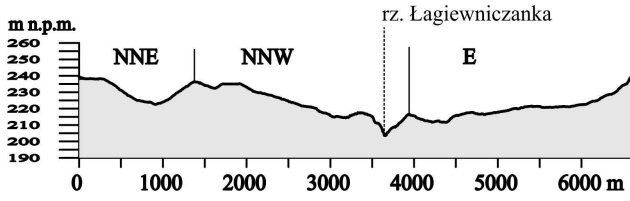


Fig. 8. Terrain profile along the black trail
Source: authors

Table 4. Basic morphometric statistics for the black trail in Łagiewnicki Forest

	Total (m)	Total length of trail sections (m)
Ascents	63.0	3,255.7
Descents	61.9	3,237.1
Total	124.9	6,492.8

Mean height difference: 19.2 m/km.
Source: authors.

Morphometrically the least varied in the Łódź Hills Landscape Park, the black trail crosses Łagiewnicki Forest following Wycieczkowa and Okólna Sts (Figs 2, 8, Table 4). Overall there are 124.92 m of height differences over a distance of 6.5 km, which gives a mean value of 19.24 m/km. On this trail, the relief attractions are mainly gullies and valleys.

Wanting to take full advantage of the attractiveness of Łagiewnicki Forest as regards relief, the authors propose designing a trail crossing the moraine hills cut with depressions and valleys (Figs 2, 9, Table 5). It is about 6 km long and offers 142 m of ascents and 133 m of descents. On average, there are 47 m of height differences per km which in some parts is comparable with trails in mountainous areas.

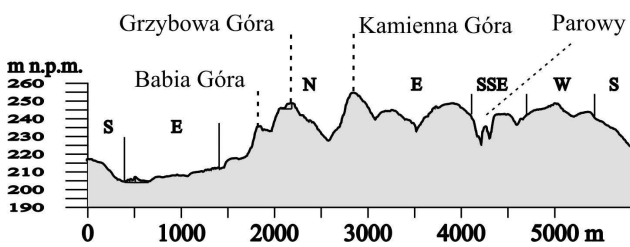


Fig. 9. Terrain profile along the trail proposed by the authors for Łagiewnicki Forest
Source: authors

Table 5. Basic morphometric statistics for the trail proposed by the authors for Łagiewnicki Forest

	Total (m)	Total length of trail sections (m)
Ascents	142.8	3,175.3
Descents	133.2	2,660.3
Total	276.0	5,835.6

Mean height difference: 47.3 m/km.
Source: authors.

The suggested trail starts at the bus terminal in Łagiewniki and runs eastwards to the ponds on the Łagiewniczanka. In the same section, a group of gullies can be found and the trail runs along one of them. Formations of this type started to appear during the last cold stage of Pleistocene (Vistulian), when the research area was situated in a periglacial climate zone. Later, erosion processes were triggered by human activity in the Middle Ages and in the 19th c. (KLATKOWA 1965, 1972, TWARDY 1995, 2002, TURKOWSKA 2006). Next, the trail runs up the Łagiewniczanka valley (Photo 2), which is deeply cut with numerous erosion landforms. Originally, the stream flowing here and joining the Leśniczanka was a tributary of the Bzura. As a result of intensive exploitation of groundwater in the Łódź agglomeration, the water table has dropped which has caused the disappearance of the Leśniczanka together with its ponds, as well as the transformation of the Łagiewniczanka above the ponds into an episodic water course. Further on, the trail turns to the north, crosses Okólna St, and climbs upwards towards the highest moraine hills of Łagiewnicki Forest. These landforms appeared as a result of the depositional activity of the Warta ice sheet (195 000-128 000 years ago; LINDNER 1992), and later they were slightly transformed by erosion processes. The effect of the deposition activity of the ice sheet and subsequent erosion can be observed in the form of two summits separated by a low col (Babia Góra, 230 m, Grzybowa Góra, 256.5 m). The next section of the path turns eastwards, where numerous gullies of the 'edge' zone of the Łódź Hills can be seen which have similar origins to those at the beginning of the trail. In the authors' opinion, the greatest attraction are the two large and deep gullies in the north-eastern part of the forest (Photo 3). Their height differences reach more than 10 metres and the vegetation cover resembles the

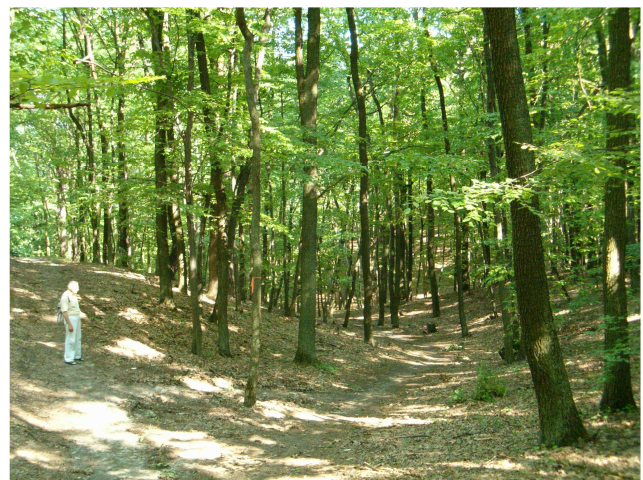


Photo 3. A gully in the north-eastern part of Łagiewnicki Forest
Photo: A. Szmidt

valleys and ravines in the Polish Upland area. It is worth paying attention to the section of the trail between the gullies and Serwituty St, with many viewpoints over the 'edge' zone of the Łódź Hills towards the Warsaw-Berlin *Urstromtal* (Photo 4).



Photo 4. A view of the 'edge' zone of the Łódź Hills and its northern foreland
Photo: A. Szmidt

The landscape seen on the trail often resembles that found in the area of the Polish Uplands and it is such a characteristic feature that it has been proposed to separate a region called the 'Łódź Upland' (DYLIKOWA 1973). Naturally, from a morphometric and genetic point of view, the area does not have upland qualities (KLIMASZEWSKI 1978, MIGOŃ 2012). However, considering the great relief diversity and the particular mixture of tree species at some places, which determine the features of the landscape, the authors suggest that the potential walking trail should be called the 'Łódź Uplands Trail'.

5. CONCLUSIONS

Łagiewnicki Forest can certainly be regarded as unique in the Polish Lowlands, considering that it is located within the administrative borders of a large city (Łódź). Apart from the standard recreational functions as a forest, it creates an opportunity to develop additional recreational and sporting activities which are difficult in this part of Poland. In this case, the authors analysed the feature of a forested area related to its varied relief. Analysing the terrain profiles along the trails and paths running through the forest, it is possible to conclude that in some parts, these trails may serve the same purpose for Łódź inhabitants for hiking as trails in the mountainous and

upland regions. Individual ascents may amount to 40 m, but by summing them along the whole trail, values close to 200 m (blue and proposed trails) are obtained. Summing the ascents and descents on the paths, the visitor must tackle nearly 400 m. Are these large values? The authors believe so. For instance, Góra Zamkowa in Olsztyn (in the Częstochowska Upland), popular among tourists, has relative heights of about 60 m. The ascent from Huta Szklana (498.9 m) to Łysiec (594.3 m) near Święty Krzyż in the Świętokrzyskie Mountains is 95.4 m, while the highest summit of the Suche Mountains in the Sudety range – Waligóra, part of the *Korona Gór Polskich* (936 m), at the junction of trails above Rybnica Leśna has a height difference of about 140 m. Considering their horizontal distance, the blue and the proposed trails, as well as many others, give similar values for ascents and descents as in the examples from the mountain and upland areas quoted above. In the authors' opinion, the large diversification of relief in the research area may be a significant attraction of Łagiewnicki Forest, particularly if its location in the lowland part of Poland is taken into consideration.

Translated by Ewa Mossakowska

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Article received:
8 September 2015