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The use of plants on balconies in the city

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Abstract: As a popular and excellent place for plants, balconies enable people easy access to and close contact with nature, thus forming an integral part of the urban green infrastructure. The aim of the study was to assess the use of plants on balconies of detached houses and blocks of flats in the small Polish town of Sieraków. Plants were grown on about 33% of the balconies of detached houses and on 51% of the balconies of blocks of flats. Most of the balconies were decorated with one plant species only and the plants were most frequently placed on the railing. The most popular plant species were *Pelargonium peltatum* (L.) L'Hér., *Pelargonium zonale* (L.) L'Hér. and *Petunia* × *atkinsiana* D. Don. There were no large differences between both the building types as regards to the balcony decoration.

Keywords: urban greening; flowers; buildings

Plants in cities mainly have a decorative function. According to Lindal and Hartig (2015), city dwellers feel the need to have flowering trees and plants in city streets. Plants not only create green space, but also positively influence the biodiversity in urban environments (Miller 2008).

Green areas. Numerous studies reveal the positive influence of green areas on the life quality and health of city inhabitants. People experience less frustration, are less irritated and feel more mentally balanced when walking in nature compared to walking in an urban environment (Aspinwall et al. 2013). A walk in a natural surrounding is also more beneficial as compared to an indoor walk (Nisbet, Zelenski 2011). People living in green urban areas have greater life satisfaction and lower stress levels (Arnberger, Eder 2015).

Urban gardening and balconies. City dwellers get in touch with plants not only through passive contact with a green infrastructure, but also through the cultivation of plants. Lindemann-Mathies and Brieger (2016) describe a great diversity of urban gardening practice, which includes the growing of plants in containers both indoors and outdoors (including on balconies) and on the roof and in community gardens. Gardening can alleviate depressive symptoms, reduce anxiety and body mass, increase life satisfaction and the quality of life, and strengthen the sense of community and involvement among neighbourhood residents. A regular dose of gardening can also improve the public health (Soga et al. 2017).

Gardening is also used as a therapeutic method. Numerous publications confirm the benefits that hortitherapy brings to people in different age groups and with different illnesses and ailments (Neuberger 2016).

However, little has been written about the role and function of balconies in this context. In Venice, balconies used to be the bridge between home and street life (Cowan 2011). In Tel Aviv, the city government makes efforts to maintain balconies in good aesthetic condition, have them open to streets and attract the attention of passers-by. However, city residents prefer to use balconies as a "barrier" protecting them from traffic noise and as additional living space at home (Aronis 2011).

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Therefore, balconies can be perceived as both an indoor and outdoor space. According to Rappe and Lindén (2004), interior plants provide a tranquil and homely atmosphere, improve the air quality at home, stimulate the senses and improve the mood. They also help one to better tolerate pain (Park et al. 2004), reduce systolic blood pressure, tiredness and anxiety (Park, Mattson 2008), as well as improve the attention capacity (Raanaas et al. 2011). Working with pot plants is a satisfactory (Rappe, Lindén 2004) and relaxing activity (Yoo, Lee 2014). Thus, it can be assumed that the contact with plants growing in containers will have similar effects. According to Chang and Chen (2005), Raanaas et al. (2011), and Nejati et al. (2016), looking out on a green space through a house or a flat window reduces the stress level and increases the resistance to stress factors (Raanaas et al. 2016). Placing plants on the balcony railing first of all improves the visual appearance of the city, because the effect can be seen when looking at the balcony from the outside. Additionally, the use of the railing enables easy access to the plants. This is of particular relevance to people with movement difficulties, especially the elderly. Plants are then within reach, and can be easily seen and smelt.

Not all balconies overlooking urban streets have flowers planted on them. The existing literature provides no information about decorating balconies with flowers and about the plant species used for this purpose. It would also be interesting to know if balconies in different types of buildings in cities are equally used to grow plants. Therefore, a study was carried out to determine the percentage of balconies with flowers and to identify the plant species grown on balconies in summer in a small tourist town, typical of western Poland. The study compares the balconies of detached houses with those of blocks of flats.

MATERIAL AND METHODS

The study on plants grown on balconies was carried out in the summer of 2015 in Sieraków (52 38'56"N 16 04'53"E), a small town located in the province of Wielkopolskie, Poland, with an area of 14 km^2 and a population of about 6 000 people. Situated next to a large forest area in the Międzychodzko-Sierakowskie Lake Region, Sieraków offers various tourist and recreational attractions, so the local government and the town dwellers regard sustainable development issues and the visual appearance of the town as an important element of the local policy and day-to-day life.

The vegetation season in and around Sieraków lasts 220 days, and the average monthly temperature is 8 °C (Urząd Gminy Sieraków 2008). The last spring frost usually occurs on 15 May, and the frost-free period lasts about 140 days (Wypych et al. 2017). During that period, until the autumn frost, people grow frost-sensitive plants that decorate their homes and the town. To get the full picture of the flowers planted on the balconies in Sieraków, the study was conducted in July.

Study. Fourteen areas with buildings with balconies were selected for the study purposes, the first half of which (1–7) were areas with detached houses, and the second half (8–14) – areas with blocks of flats (Figure 1). The map showing the selected areas was prepared based on http://sierakow.e-mapa.net/. In each of those fourteen areas, the balconies were counted and the percentage ratio (per area) of the number of balconies with flowers to the total number of balconies was calculated. The balconies with flowers were analysed according to the following criteria: use of one vs. at least two species; place of containers with plants on the balcony; balcony orientation; plant species being grown on the balcony.

For each feature identified using these criteria, the percentage share in the total number of flowered balconies was calculated within each area. Additionally, containers with plants were counted on each flower-decorated balcony. Subsequently, the obtained results were used to compare areas 1–7 (detached houses) with areas 8–14 (blocks of flats). The names of plants were used according to Erhardt et al. (2014).

Statistical analysis. The normality of the distributions of the observed features were tested using Shapiro-Wilk's normality test (Shapiro, Wilk 1965). One-way analyses of variance (ANOVA) were performed in order to verify the zero hypothesis on the lack of differences between the detached houses and blocks of flats in terms of the values of the observed features, independently for each feature. The statistical analyses did not only cover the percentage shares of balconies with specific plant species. The minimum and maximum values of the observed feature as well as the arithmetical means and standard deviations were calculated. Moreover, Fisher's least significant differences (LSDs) were estimated at the significance level $\alpha = 0.05$ (Meier 2006). The relationships between

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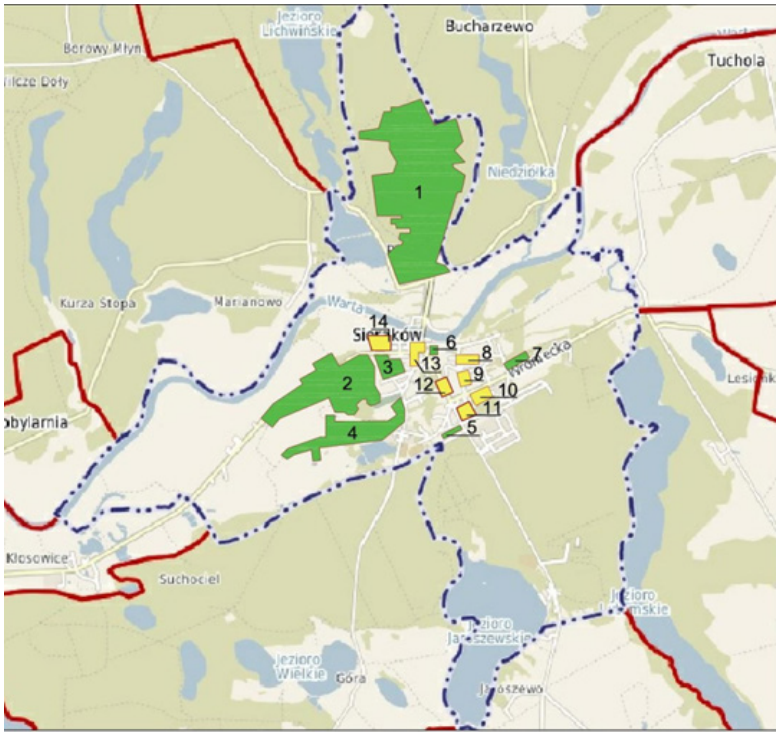

Figure 1. Areas selected for the study

the observed features were assessed on the basis of Pearson's correlation coefficients using the FCORRELATION implementation in GenStat v. 18. The results were also analysed using multivariate methods (Rencher 1992). The principal components analysis was applied in order to present the multi-feature assessment of the similarity of the tested area. The principal components analysis finds the linear combinations of a set of variates that maximise the variation contained within them, thereby displaying most of the original variability in a smaller number of dimensions. In order to determine the relative share of each original feature in the multivariate variation of the analysed treatments, Pearson's simple correlation coefficients were estimated between the values of the first two principal components and the values of the individual original features. The differences among the analysed areas were verified by a cluster analysis using the nearest neighbour method and Euclidean distances (Camussi et al. 1986; Wrońska-Pilarek et al. 2020). All the analyses were conducted using the GenStat v. 18 statistical software package.

RESULTS AND DISCUSSION

In the seven detached-house areas under study, there were 342 balconies, 33.4% of which were decorated with plants, whereas in the seven areas with blocks of flats, there were 417 balconies, and plants were growing on 51% of them (Table 1). The differences between those values were not statistically significant.

According to Berg et al. (2007), people place plants on balconies because they have always felt the need to decorate their immediate surrounding with plants to increase the aesthetic quality of their environment and have closer contact with nature. A balcony can be a substitute for a garden. In the analysed area in Sieraków, slightly over one-half of the balconies in the blocks of flats had flowers on them, which suggests the need to create an enclosed space enabling contact with plants. However, the share of the flowered balconies could have been higher. The reason may have been the prices of the plant and certain limitations to growing plants on balconies. According to Fan and Wang (2011), plant growing on balconies may be problematic due to thin soil layers, the low insulation and moisture retention of the soil used in containers.

Balconies with one and more plant species. The study showed that most of the balconies were decorated with one plant species only (Table 1), which was either *Pelargonium peltatum* (L.) L'Hér. or *Pelargonium zonale* (L.) L'Hér. or *Petunia* × *atkinsiana* D. Don.

Fifteen percent of the balconies of detached houses and 31.3% of the balconies of blocks of flats had two or more plant species displayed on them. There were, on average, about three containers with

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Table 1. Range (min-max), mean values and standard deviations (s.d.) of the studied features. One-way ANOVAs were performed separately for each feature

Type of buildings	Percentage of balconies: with plants			with one plant species			with at least two plant species			Average number of containers on the balcony		
	range	mean	s.d.	range	mean	s.d.	range	mean	s.d.	range	mean	s.d.
Block of flats	25–100	51.0[a]	25.1	30–100	68.7[a]	25.1	0–70	31.3[a]	25.1	2–5.2	3.3[a]	1.09
Detached house	13.6–50	33.4[a]	11.8	66.7–100	85.0[a]	13.7	0–33.3	15.0[a]	13.7	1.5–4	3.0[a]	1.01
$LSD_{0.05}$		22.81			23.52			23.52			1.227	
P-value		0.12			0.156			0.156			0.656	
	percentage of balconies with plants in containers placed on: railing			ceiling			floor			wall		
	range	mean	s.d.	range	mean	s.d.	range	mean	s.d.	range	mean	s.d.
Block of flats	50–100	81.1[a]	17.2	0–25	12.1[a]	9.69	0–47	23.1[a]	17.2	0–33	10.9[a]	11.3
Detached house	50–100	88.7[a]	18.7	0–17	2.4[b]	6.43	0–55	21.6[a]	20.1	0–36	11.4[a]	15.7
$LSD_{0.05}$		20.89			9.57			21.74			15.94	
P-value		0.445			0.047			0.877			0.939	
	percentage of balconies facing: North			South			East			West		
	range	mean	s.d.	range	mean	s.d.	range	mean	s.d.	range	mean	s.d.
Block of flats	0–25	5.3[b]	9.8	0–84	34.2[a]	36.5	0–100	35.5[a]	34.3	0–80	25.1[a]	26
Detached house	0–100	37.9[a]	35.6	0–50	17.6[a]	18.9	0–100	38.6[a]	32.3	0–18	6.0[a]	7.94
$LSD_{0.05}$		30.37			33.85			38.8			22.35	
P-value		0.038			0.306			0.865			0.088	

Means followed by the same letters are not significantly different; LSD – least significant differences; s.d. – standard deviation

plants on one balcony regardless of the building type, which shows the need to create flower arrangements. However, to have high decorative and aesthetic value, flower arrangements need to be designed carefully and with taste and placed in attractive containers (Lindemann-Matthies, Brieger 2016). A large number of plants on a balcony may also create a view out of the window.

Place of containers with plants on the balcony. On most of the balconies of the detached houses and blocks of flats, the containers with plants were placed on the railing (80%). On over 20% of the balconies, the containers were placed on the floor, and on about 11% of the balconies - on the wall (Table 1). No statistical differences as regards to the placing of the plants were identified between the analysed building types. The only exception were the balconies with plants hanging from the ceiling, whose share was higher in the blocks of flats (their percentage values for the blocks of flats and the detached houses were 12.1% and 2.4%, respectively).

Balcony orientation. Plants were grown on balconies with various exposures (Table 1). In the blocks of flats, there were 32.6% less north-facing balconies with plants than in the detached houses. Of all of the geographical directions, a northern exposure is the least favourable for planting because it receives the least amount of sunlight. However, despite this drawback, over 37% of the flowered balconies of the detached houses were facing north. The two building types did not statistically differ with respect to the number of flower-decorated balconies with a southern, eastern and western exposure. According to surveys carried out in Serbia (Mladenović et al. 2017), half of the respondents buy plants for the balcony based on their appearance and do not pay attention to their growing requirements and conditions.

Plant species grown on the balcony. In total, twenty plant species were grown on the balconies under study (Table 2), with a greater variety of species found on the balconies of the blocks of flats. *Pelargonium peltatum* enjoyed the greatest popularity (51.8% of the balconies of the detached houses and 42.1% of the balconies of the blocks of flats). Slightly over 30% of the balconies of both building types were decorated with *Pelargonium zonale* and *Petunia* × *atkinsiana* was grown on 18.5% of the balconies of the detached houses and on 24.7% of the balco-

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Table 2. Plants used to decorate the balconies of the detached houses and blocks of flats in Sieraków and the percentage of the balconies on which they were planted

Plant species	Percentage of balconies	
	detached house	block of flats
Begonia cucullata Wild. var *hoockeri* (A. DC.) L.B. Sm.et B.G. Schub.	1.2	1.2
Begonia tuberhybrida Voss	0.0	1.9
Calibrachoa parviflora (Juss.) D'Arcy et Wijsman	1.2	5.6
Dianthus chinensis L.	0.0	1.2
Fuchsia hybrid Voss	0.0	3.1
Gazania rigens (L.) Gaertn.	0.0	1.2
Helichrysum petiolare Hilliard et B.L. Burtt	0.0	3.1
Lavandula angustifolia Mill.	0.0	1.9
Lobelia erinus L.	0.0	4.9
Nerium oleander L.	1.2	0.0
Pelargonium peltatum (L.) L'Hér.	51.8	42.0
Pelargonium zonale (L.) L'Hér.	33.3	34.6
Petunia x atkinsiana D. Don	18.5	24.7
Phaseolus coccineus L.	0.0	0.6
Plectranthus forsteri Benth.	4.9	13.0
Plectranthus scutelarioides (L.) R. Br.	0.0	2.5
Sanvitalia procumbens Lam.	0.0	3.1
Sutera grandiflora (Galpin) Hiern	1.2	3.1
Tagetes patula L.	0.0	1.9
Tropaeolum majus L.	0.0	1.9

nies of the blocks of flats. *Pelargonium peltatum* and *Pelargonium zonale* are among the most preferred flower species used for summer arrangements in different parts of cities. They were found to be planted in the most abundant numbers on the balconies of a Serbian town (Mladenović et al. 2017) and in gardens cafés in Cracow, Poland (Pawłowska, Szewczyk-Taranek 2010). The widespread popularity of geraniums is probably attributable to their easy cultivation and availability in a wide range of cultivars.

Other plant species were used rarely. Only three species identified on the balconies were non-flowering species, with ornamental, multi-coloured leaves. Among those plants, *Plectranthus forsteri* Benth. had the largest share – it was grown on 4.9% of the balconies of the detached houses and on 13.0% of the balconies of the blocks of flats. The remaining sixteen plant species were found on less than 10% of the balconies of both building types.

The balconies were not used for growing useful plants, like those with edible fruit, e.g., strawberries, as suggested by Olbricht et al. (2014).

Area comparison. A principal component analysis was used to jointly compare the areas in terms of all the features. The first two principal components explain 59.64% of the overall multi-feature variability between the areas (Figure 2A). On the chart, the point coordinates for the individual areas are the values of the first and the second principal component, respectively. The multi-feature variance between the areas was most strongly influenced by: the percentage of balconies with at least two plant species, the percentage of balconies with plants in containers hanging from the ceiling, and the percentage of balconies with a southern exposure (positive correlation), and the number of balconies with one plant species, the percentage of balconies with an eastern exposure and the percentage of balconies with a northern exposure (negative correlation). A correlation was identified between area 1 and 2, which are comprised of detached houses built in recent years. A correlation was also found between area 3 (detached houses) and area 11 (blocks of flats) in which the houses were built several decades ago.

The clustering of the studied areas using Euclidean distances for twelve analysed features yielded four clusters at a similarity level of 0.825. Cluster 1 comprised areas 6, 8; cluster 2 – area 12; cluster 3 –

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areas 1, 2, 3, 4, 5, 7, 11, 13; and cluster 4 – areas 9, 10, 14 (Figure 2B). All of the similarity values between the areas were very high, which shows small differences between them. The distinguished clusters do not consist of areas with buildings of the same type. It is, thus, difficult to describe the balconies with

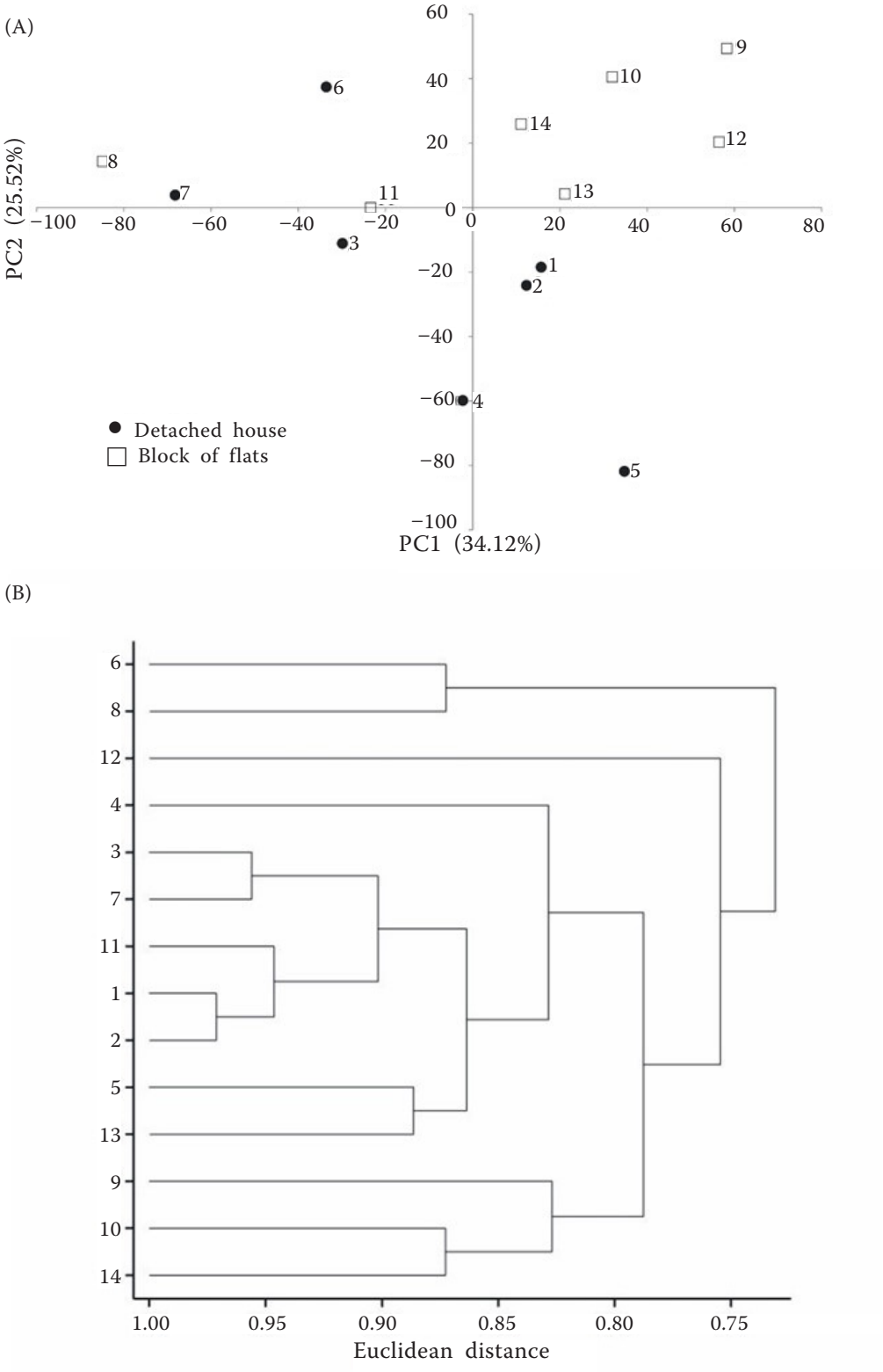

Figure 2. Similarity of 14 areas: (A) in the space of the first two principal components (PC1 and PC2), (B) dendrogram based on 12 qualitative features

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plants in Sieraków in dependence of the building type. This suggests that the residents of the respective areas do not differ in terms of what species they prefer to plant on their balconies.

CONCLUSION

In Sieraków, a small Polish city, plants were found to grow on half of the balconies in the blocks of flats and in one-third of the balconies of the detached houses. The residents of both the detached houses and blocks of flats make an effort to improve the visual appearance of their neighbourhoods, e.g., by growing plants on balconies. In most cases, they grow one plant species, notably *Pelargonium peltatum*, *Pelargonium zonale* or *Petunia* × *atkinsiana* in planters on the railing. The town residents did not grow crop plants on the balconies. Gardening on the balconies should be promoted so as to further increase the presence of plants in a human environment. The local government could make a valuable contribution in this respect through relevant educational measures, e.g., lectures, training courses, workshops or competitions.

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