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Residents’ awareness of the role of informal green spaces in a post-industrial city, with a focus on regulating services and urban adaptation potential

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Abstract

Urban green spaces (UGS) and the ecosystem services they provide are essential for the health and wellbeing of city dwellers. UGS are increasingly seen as a potential solution for sustainable urban planning and development. Informal green spaces (IGS), even though they may make up a large share of UGS, are often overlooked in this regard. This study examines residents’ awareness of the ecosystem services provided by IGS and their need for redevelopment. The data were collected through structured interviews in the immediate vicinity of selected IGS in the Polish city of Łódź. Łódź is typical of post-industrial European cities struggling with environmental (heatwaves, cloudbursts), social (aging, depopulation) and spatial (a neglected and dense city center) issues. Our results show that residents saw IGS as places able to provide a range of services, mostly of the regulating type, and even minor design interventions can improve the attractiveness of IGS. Taking this into account, we conclude that IGS are important vegetated areas in the city, which can be complementary to formal greenery.

Keywords:
Informal green spaces
Perception
Urban ecosystem services
Spatial change
Redevelopment

1. Introduction

Modern society, despite the advancement of technology, relies on goods and services derived from nature – not only for mental and physical regeneration and for the cultural and educational values nature offers to humans and food provision, but also, more importantly, for clean air, soil regeneration, water purification and disaster risk reduction (Alcock, White, Wheeler, Fleming, & Depledge, 2014; Kabisch et al., 2016; Liu, Chen, & Peng, 2014; Millennium Ecosystem Assessment, 2005). One of the key challenges of the modern world is to provide these services to the growing population of cities (World Health Organization, 2016). This brings urban green spaces (UGS) to the center of attention as a premise of citizens’ wellbeing (European Environment Agency, 2009, 2010a, 2012; European Environment Agency & Joint Research Centre, 2013; Kim & Miller, 2019), and a sine qua non for cities’ long-term sustainability, built on a range of regulatory services recognized as nature-based solutions (Cohen-Shacham, Walters, Janzen, & Maginnis, 2016; European Commission, 2015). Moreover, access to UGS has become a pressing environmental-justice issue in densely populated areas (Laszkiewicz, Kronenberg, & Marciniak, 2018). However, city managers are confronted with multiple barriers to establishing new green spaces, mostly due to spatial and financial restrictions (Kronenberg, 2015). The most commonly desired UGS – urban parks and forests – are frequently not sufficient to meet the demand for services due to their location (usually the outskirts of city centers, or even in suburban areas) or limited size or location options, hence the role of alternative green areas has been highlighted, e.g. cemeteries (North, Evesen, & Skar, 2017), allotment gardens (Soga et al., 2017), or residential greenery (Battisti, Pille, Wachtel, Larcher, & Säumel, 2019). One recently studied option involves considering various patches of vegetated areas scattered throughout the city which are not included in the city’s planning documents as UGS, but provide numerous benefits to residents (walking paths and pet areas, recreational spaces, urban agriculture lots). Such places are referred to as informal green spaces (IGS). Although they are defined in various ways, in general they are all neglected areas which are not formally recognized or planned for recreational use by inhabitants (Pietrzyk-Kaszyńska, Czepkiewicz, & Kronenberg, 2017; Rupprecht & Byrne, 2014a, 2014b). It is also possible to create new green infrastructure in dense cities on urban vacant land through smart growth principles such as in-filling, brownfield and greyfield redevelopment/recycling (European Environment Agency, 2016; Kim, 2018).

From an ecological point of view, IGS have a large potential to regulate air quality, flood risk and temperature and to promote urban biodiversity (Bonthonx, Brun, Di Pietro, Greulich, & Bouché-Pillon, 2014; Brun, Di Pietro, & Bonthonx, 2018). This is due to the processes...
of ecological succession which structurally and functionally differentiates them from man-made and artificially maintained green spaces (Kowarik, 2013; Mathey, Arndy, Banse, & Rink, 2018). IGS also have a potential to act as connectors within a larger green network, providing an ecological connectivity of green spaces as a basis for sustainable and restorative development of a city (e.g. Krauze & Wagner, 2019). Even if they are not intended for recreational use, studies show that IGS offer opportunities for spending free time (Brun et al., 2018; Kremer, Hamstead, & McPheerson, 2013; Rall & Haase, 2011; Rupprecht, Byrne, Ueda, & Lo, 2015; Unt & Bell, 2014) and enable residents to interact with nature (Rupprecht et al., 2015). Despite the rationality of increasing areas dedicated to greenery in cities to mitigate climate change effects (e.g. heatwaves and cloudbursts (Grimm et al., 2008; Depietri et al., 2012), Cortinovis et al. (2019) noted that the majority of European cities (EU) are experiencing a reduction in urban green spaces, and almost none had halsted land development (European Environment Agency, 2010a, 2010b, 2015, 2016, 2019). If some cities have managed to become greener (particularly in the Northern and Eastern EU), it has been mainly due to urban expansion. These changes also affect shrinking cities, and in every case they trigger negative social and ecological phenomena (European Environment Agency, 2010b; Cortinovis et al., 2019). A comparison of urban spatial development strategies among European cities (Cortinovis et al., 2019) showed that achieving a higher population density in a city only co-occurred with enhancing green space availability in few cases.

Consequently, the incorporation of IGS as temporary green spaces in cities could help to address several issues, e.g. eco-gentrification and social exclusion, hydro-meteorological hazards, quality of life for city dwellers, and urban ecosystem health (Kim, Miller, & Nowak, 2018). This can be an especially important issue in cities in the transitional phase with shrinking and aging populations, resulting in higher numbers of vacant lots and a loss of green areas (Kronenberg, Krauze, & Wagner, 2017). It requires moving away from perceiving those spaces as a spatial and economic burden, and considering them as valuable social and ecological resources in planning processes (Kim, 2015).

If and how people use green spaces depends on their accessibility, affordability and attractiveness (Biernacka & Kronenberg, 2018). Direct use is strongly related to residents’ perception and how they subjectively assess the area. The benefits of city parks have been explored the most thoroughly (e.g. Bedimo-Rung, Mowen, & Cohen, 2005; Brown, Schebella, & Weber, 2014; Dou, Zhen, De Groot, Du, & Yu, 2017; Langemeyer, Baro, Roebeling, & Gomez-Baggethun, 2015; Rall, Bielin, Zytynska, & Haase, 2017). Studies generally focus on the cultural ecosystem services provided by formal green spaces (see the Appendix A). Work covering citizens’ recognition of the regulating services provided by urban parks and greenery is much scarcer (e.g. Bertram & Rehdzan, 2015; Jim & Chen, 2006; see the Appendix A). IGS have been considered even less frequently (e.g. Mathey et al., 2018; Weber, Kowarik, & Saumel, 2014, Table 1, Appendix A). Little is also known about the needs of local residents in terms of redevelopment of IGS (Mathey et al., 2018). As the attractiveness of the space plays an important role in how people consider the value of greenery, the perception of IGS can be highly diverse. They are perceived as problematic in some areas which are aesthetically undervalued (e.g. unpleasant spaces, perceived as a landfill or a source of social problems) (Brun et al., 2018), undisturbed and dangerous due to the structure of the vegetation (Jorgensen, Hitchmough, & Dunnett, 2007; Mathey et al., 2018). Conversely, some people see IGS as useful, valuable, highly natural spaces (Brun et al., 2018), characterized by wildness, uniqueness (Pietrzyk-Kaszyńska et al., 2017), biodiversity, and tranquility (Rupprecht et al., 2015).

This paper focuses on IGS in Łódź (central Poland). The aim was to investigate i) the attractiveness and uses of UGS not intended for recreation, ii) the awareness of ecosystem services provided by IGS, iii) conservation vs. redevelopment of IGS, and iv) favorable uses and management of such sites as a basis for planning decisions and policy intervention.

2. Materials and methods

2.1. Study area

Łódź is the third largest city in Poland in terms of population (687,702) and the fourth largest in terms of area (293.25 km²). Prior to the political and economic changes of 1989, it was a center of the textile industry. Today it is a typical post-industrial city in a transition stage towards new economic and management schemes.

The development of the city took place at the expense of environmental resources. The rapid development initiated in the second half of the 19th century resulted in dense urban development, air, soil and water pollution, and the canalization of watercourses. The economic and social transition initiated in 1989 has led to economic depression (high unemployment, soaring inflation, a significant decrease of GDP) (Kronenberg et al., 2017; Stawasz, 2016), but it also introduced new socio-cultural patterns, which have caused further urbanization and urban sprawl (Kronenberg & Bergier, 2012; Wagner & Breil, 2013). Despite significant improvement after the accession to the European Union, Łódź is still struggling with unemployment (6.3 % in 2017), low GDP per capita (59 347 PLN in 2016) and relatively low average monthly gross wages (4462.50 PLN in 2017, ca 1000 Euro). This indicators classify Łódź below the national average and averages for Polish towns over 450 thousand inhabitants (PwC, 2015, 2019; Statistical Office in Łódź, 2018; Szukalski, Martinez-Fernandez, & Weyman, 2013). Different stages of the city’s development, as well as its economic and political history, have led to negative effects on the wellbeing of its inhabitants, conditioned by environmental goods and environmental risk (Krauze & Włodarczyk-Marciniak, 2018; Kupryś-Lipińska, Kuna, & Wagner, 2014).

In recent years, Łódź has been facing serious demographic challenges such as a rapid shrinking and aging of the population. By 2015, Łódź lost almost 20 % of its population, meanwhile, in other large Polish cities, the process was much less dynamic (Krysztofik & Szmytkie, 2018). The forecast indicates further decline in population by 2050, resulting in a loss of youth and skilled professionals for the region (Szukalski et al., 2013). It is also experiencing accelerated population aging, in 2017 there were 22.3 % of population aged 65 years and more, and by 2050 it may reach about 37.5 % (Statistical Office in Łódź, 2018). Łódź also struggles with high mortality and morbidity rates, a low fertility rate and low migration attraction (Perek-Białoś, Sagan, Stronkowski, & Szukalski, 2017; Szukalski, 2012, 2015). Furthermore, the city is highly divided in terms of place of residence. The central zone is mainly home to low-income and unemployed residents, while the upper and middle classes tend to live outside the old core of the city. This is due to the fact that instead of allocating funds to the reconstruction and revitalization of the pre-war housing stock during the communist period (after the Second World War), efforts were instead focused on building vast residential areas on the outskirts of the city (Marciczaś & Sagan, 2011). This has led to a societal degradation of the city center and to collapse of its physical attributes (Marciczaś & Sagan, 2011). The differences between the city center and its outskirts are also reflected in the health of residents of different zones, e.g. children from the center have a significantly lower body mass and height (Rosset et al., 2012). A similar effect can be noted for the prevalence of asthma in both adults and children, as well as seasonal rhinitis in children (Kupryś & Kuna, 2003; Kupryś-Lipińska, Elgalal, & Kuna, 2009; Kupryś-Lipińska, Elgalal, & Kuna, 2010).

Furthermore, although green spaces cover 61.2 % of the city (Feltynowski et al., 2018), their accessibility is limited, especially in the city center (Kabisch, Strohbach, Haase, & Kronenberg, 2016; Laszkiewicz et al., 2018; Sikorska, Laszkiewicz, Krauze, & Sikorski, 2020). According to Sikorska, Laszkiewicz, Krauze, & Sikorski, 2020, this statistic also includes arable land, private greenery and unmanaged
green spaces, which account for 85.43% of all vegetated areas. Consequently, only a minority of residents have access to high-quality managed greenery. This especially affects children in Łódź, since only just over 1% of them have good access to parks. According to the same studies, 77% of those citizens who do not have formal green spaces in their surroundings do have access to IGS. The location of formal green areas in the vicinity of city residents, a high proportion of greenery not being included in urban green space planning and governance, and unequal access to greenery, all make Łódź an important location for analyzing the benefits and management options of IGS.

2.2. Data collection

An inventory of IGS in the city of Łódź was performed using an orthophoto map (2017) along with the city’s vector land use database to exclude formal green areas and define potential sampling plots. Preliminary studies were carried out in 40 IGS. Fenced sites, those with limited access, and those located within housing estates were excluded. In total, five locations were selected for further research (Table 2, Fig. 1). Most of the sites were located in or adjacent to the low income areas of Łódź with a predominance of tenement houses (only the fifth location is outside the degraded area, but the poverty and unemployment rates are similar, the difference is manifested mostly in the predominance of blocks of flats over tenement houses). The majority of inhabitants do not have access to private and community gardens, nor formal green areas of appropriate quality and size with adequate infrastructure in close distance. Two of them represented street greenery (with and without trees, with low levels of maintenance) and three abandoned, derelict sites at different succession phases (with spontaneous pioneer or ruderal vegetation, no maintenance). All sites were selected as the biggest green patches within the neighborhood, and due to proximity of housing.

Data on visitor perception was collected through structured interviews in the immediate vicinity of the selected IGS (see the Appendix B). Since respondents were interviewed on-site (convenience sampling), their replies depended on their familiarity with the area and the direct visual perception of the IGS. The structured, face-to-face interviews were conducted with randomly selected passers-by during two two-hour visits (morning and afternoon) between August and September 2017. The interviews were conducted under similar weather conditions (sunny, above 25 °C). In total, 20 conversations were conducted at each location.

The first part of the questionnaire asked the respondents about their use of IGS (closed-ended questions). The second part explored the respondents’ recognition of ecosystem services at the sites, with questions such as “What does the site provide for you?”. Respondents could choose from a list of 11 services: five cultural ecosystem services, i.e., looking after their mental health (relaxation), maintaining physical health (recreation), educational use, aesthetic function and inspiration; four regulating services, i.e., air purification, temperature regulation, rainwater retention and noise reduction; provisioning service, i.e., foraging for flowers, fruit and nuts; and supporting services, i.e., habitats for plant and animal species. Finally, the third part asked open-ended questions whether the respondents would like to change anything at the site, and what would it be. The questionnaire also contained a section on socio-demographic data (gender, age, education) (see the Appendix B).

2.3. The interviewees profile

As respondents were randomly selected in the immediate vicinity of the IGS, they did not present equally distributed characteristics. We interviewed 57 women and 43 men (the predominance of women in the group is consistent with the male/female ratio in Łódź). Among them, the majority were young, aged up to 39 (46 people), while 27 respondents were in the middle age (between 40–59) and 27 were elderly.
Just six people had low levels of education, with the majority having attained middle education (56 people). There were 36 people who had completed higher education. Among respondents, the majority were employed (64 people), while 23 respondents were retired, 6 were students and 7 were unemployed.

2.4. Data analysis

We used the chi-square test (Yate’s chi-squared test, for a table when at least one cell had an expected count lower than five) to analyze the relationship between the identified ecosystem services and i) variables characterizing green areas (type of IGS and percentage of tree cover) and ii) respondents’ socio-demographic characteristics. To determine the strength of the relationship between the variables, contingency coefficients – measures of association – were calculated (Pearson’s contingency coefficient C for a $2 \times 2$ contingency table, and Cramér’s V for variables having more than two levels). In order to identify potential co-occurrence of ecosystem services based on the respondents’ opinions, we carried out hierarchical cluster analysis (HCA) using the single linkage method with Euclidean distances. We performed a multiple correspondence analysis (MCA, an ordination technique for categorical data) to determine the links between IGS characteristic and any desired design interventions. Statistical analyses were performed using StatSoft Inc., STATISTICA 12.

3. Results

3.1. Identification of ecosystem services

Overall, 98 % of respondents recognized that IGS can provide benefits to society. The most commonly identified services were retention of rainwater (68 %) and providing habitats for plants and animals (68 %). Foraging for flowers, fruit and nuts was the least common (12 %). Among cultural ecosystem services, the aesthetic function was indicated the most (59 %) and inspiration the least frequently (15 %). Our results indicate that respondents were more likely to associate regulating than cultural ecosystem services to IGS (Fig. 2).

Based on the HCA, we distinguished three sets of ecosystem service co-occurrence. The first set contains a high diversity of services, including cultural services (aesthetic function), supporting services (habitat for species) and regulating services (rainwater retention). The second set is mostly dominated by cultural services (recreation, inspiration, educational use), plus one provisioning service (foraging). The third set mainly includes regulating services (temperature regulation, air purification, noise reduction) and one cultural (relaxation) (Fig. 3).

3.2. Factors influencing citizens’ awareness of different ES categories

There were significant relationships with weak correlation between interviewee age and their recognition of just three ecosystem services provided by IGS: aesthetic function (Chi$^2$, $p < 0.05$, Cramér’s V = 0.263), relaxation (Chi$^2$, $p < 0.05$, Cramér’s V = 0.261) and noise reduction (Chi$^2$, $p < 0.05$, Cramér’s V = 0.246). Elderly respondents were more likely to associate IGS with the maintenance of good mental health and noise reduction. Aesthetic function was noted more frequently by younger people (Fig. 4). The results also revealed a relationship between higher education and recognition of such services as rainwater retention (Chi$^2$, $p < 0.05$, Cramér’s V = 0.294) and aesthetic function (Chi$^2$, $p < 0.05$, Cramér’s V = 0.336) of IGS (Fig. 5).

The maintenance level of IGS (unmanaged, such as abandoned areas, and irregularly managed, such as street greenery) was related to...
both the aesthetic function (Chi², p < 0.05, contingency coefficient C = 0.486) and rainwater retention (Chi², p < 0.05, contingency coefficient C = 0.323) (Fig. 6). The results also revealed a strong correlation between tree coverage and the perception of such ecosystem services as temperature regulation (Chi², p < 0.05, Cramér’s V = 0.460), noise reduction (Chi², p < 0.05, Cramér’s V = 0.309), purification of air (Chi², p < 0.05, Cramér’s V = 0.345) and maintaining good mental health (Chi², p < 0.05, Cramér’s V = 0.318) (Fig. 7)).

3.3. Suggestions for interventions in informal urban green spaces

Almost all respondents (N = 93) expressed a desire to introduce changes to the site under evaluation. Their answers were grouped into six categories:

1. orderliness, including cleaning up the area, mowing herbaceous vegetation (grass, herbs, flowers), and pruning trees;
2. greening measures, such as creating lawns and flowerbeds and tree planting;
3. functionality, such as introducing playgrounds, recreational facilities for sports and games, walking paths and street furniture (benches);
4. elimination and substitution by commercial and service buildings;
5. formalization as a formal green space;
6. security, such as eliminating alcohol consumption.

The descriptive statistics of the categorized suggestions for the design of IGS are included in Table 3. The majority of respondents pointed out a need for orderliness, i.e. increased maintenance (such as mowing herbaceous vegetation and pruning trees) and cleanliness (removing garbage). Improvements to functionality were suggested almost as frequently as orderliness, and included improvements to passive and active rest with benches, playgrounds or outdoor gyms and walking paths. Improvements to the greenery itself were suggested less frequently and included tree planting and beautification, for example with flowerbeds. Improving accessibility to a given area was suggested rarely, as was setting up formal green spaces. Only 2% of respondents suggested building up the area and thus removing the greenery. The
majority of respondents pointed out an absence of alternative green areas in their neighborhoods, which would allow them to relax on hot days, play with their children or walk their dog.

The first two axes of the MCA accounted for 33.18 % of the inertia (Fig. 8). The first axis (20.81 % of inertia) divided IGS redevelopment suggestions into unmanaged, large IGS at far from roads, and irregularly managed, small IGS close to roads. The second axis (12.37 % of inertia) mainly relates to the division due to tree coverage. Benches, playgrounds, recreational facilities for elderly people and walking paths were mainly suggested for unmanaged, large IGS far from roads. Pruning trees, eliminating alcohol consumption and cleaning up the area were mainly suggested for IGS with large tree coverage. Greening measures, such as creating flowerbeds, planting trees and maintaining neat lawns, were suggested for irregularly managed, small IGS far from roads. Planting trees was also more frequently suggested for IGS with small tree coverage.

4. Discussion

In general, this study reveals that (i) residents perceive IGS as places able to provide a range of services, mainly regulating services, (ii) even low-scale design interventions can improve the attractiveness of IGS, and (iii) IGS are regarded as important vegetated areas in the city which can be complementary to formal greenery.

4.1. Awareness of ecosystem services

The results show that Łódź residents do associate IGS with ecosystem services, in particular with habitat provision for wildlife, rainwater retention, air purification, local temperature regulation and aesthetic function. This is consistent with the findings of previous studies, showing that citizens recognize that IGS provide a number of benefits (Kim, Rupprecht, & Furuya, 2018; Rupprecht, 2017). Some studies suggest that cultural and provisioning services are identified more easily than regulating and supporting ones, since they are experienced directly (Andersson, Tengö, McPhearseon, & Kremer, 2015; Brown, Montag, & Lyon, 2012; Daniel et al., 2012; Puefelf, Haase, & Priess, 2018), while services not experienced directly may be under-valued or not recognized at all (Scholte, van Teeffelen, & Verburg, 2015). Our study confirms the results reported by Graca, Queiros, Fariinha-Marques, and Cunha (2018), Kim, Rupprecht et al. (2018), Pietrzyk-Kaszyńska et al. (2017) and Rupprecht (2017), showing that people are aware of IGS as providers of habitats and regulating services, and that environmental functions of IGS are predominant in community awareness.

Although many research results show that IGS are able to efficiently fill a gap in the availability of urban, green recreational spaces (Mathey, Rößler, Banse, Lehmann, & Bruier, 2015; Pietrzyk-Kaszyńska et al., 2017; Rupprecht & Byrne, 2014b; Rupprecht, 2017), in our case the majority of users treated IGS as shortcuts rather than destination points (e.g. dog walking); this may have been due to constraints discussed further in the paper.

Despite a global increase in interest in urban agriculture and foraging for fruit/plants, our respondents did not consider wild plant harvesting (flowers, nuts, fruit) in IGS in Łódź. It should be noted that our results do not indicate levels of foraging; they simply show that just 12 % of respondents admitted that IGS could be used for urban foraging. This may reflect concerns about whether urban plants are suitable for eating (Russo, Escobedo, Cirella, & Zerbe, 2017), e.g. due to metal contamination (e.g. Antisari, Orsini, Marchetti, Vianello, & Gianquinto, 2015; Säumel et al., 2012). This bias is unfortunate because urban foraging could be an important and widely accessible way of handling environmentally-friendly production and transport of food, and tackling social issues such as poverty (Landor-Yamagata, Kowarik, & Fischer, 2018; Russo et al., 2017; Shackleton, Hurley, Dahlberg, Emery, & Nagendra, 2017). More information may be needed on the subject, including issues favoring the development of IGS which may provide food provisioning, for example by introducing natural barriers to pollution (e.g. planting trees along the street (Al-Dabbous & Kumar, 2014)).

In line with previous studies (Kim, Rupprecht et al., 2018; Rupprecht, 2017), IGS are recognized by residents as important wildlife refuges. Additionally, studies focused directly on analyzing species diversity at sites with spontaneous vegetation confirm this belief (Bonthoux et al., 2014). Rarely mown or never mown IGS, which are frequently found in cities, support flora and fauna which otherwise would not have a chance to flourish (Threlfall & Kendal, 2018). Respondents recognizing IGS as valuable habitats for species may indicate their general environmental awareness.

Most studies attempting to link socio-demographic factors with people recognizing or valuing the benefits of IGS show no (Kim, Rupprecht et al., 2018) or a limited (Graca et al., 2018; Rupprecht et al., 2015) relationship. In our study, respondents showed a high awareness of ecosystem services of IGS; this is related not only to their age or education, but also to the features of the site (e.g. tree coverage, management level). However, socio-demographic factors appear to be statistically related with just three UES: aesthetic function, mental

Table 3

| Low-scale design intervention | Coding (n = 93) % |
|------------------------------|------------------|
| Orderliness                  | 60               |
| mowing herbaceous vegetation (grass, herbs, flowers) | 42              |
| pruning trees                | 29               |
| cleaning up the area         | 14               |
| Functionality                | 57               |
| street furniture (benches)   | 47               |
| playgrounds                  | 14               |
| walking paths                | 10               |
| recreational facilities for sports and games | 9               |
| Greening measures            | 41               |
| flowerbeds                   | 25               |
| tree planting                | 23               |
| neat lawns                   | 4                |
| Formalisation                | 13               |
| creation of formal green spaces | 13          |
| Security                     | 12               |
| elimination of alcohol consumption | 12          |
| Elimination                  | 2                |
| commercial and service buildings | 2              |

Fig. 8. Multiple correspondence analysis (MCA) of IGS characteristics and respondents’ ideas/perceptions. Variables marked with rectangles represent the characteristic of the analyzed IGS, and the grey variables represent design interventions.
health benefits and noise reduction. The aesthetic function of IGS was more highly recognized by younger and highly educated people. Elderly respondents were more likely to recognize the positive influence of IGS on mental health and noise reduction. This could be related to generational variance and age-related needs, which is linked with a higher physical and mental vulnerability of the elderly. The findings are concordant with those by Van den Berg and van Winsum-Westra (2010) and Van den Berg and Koole (2006), where people with an academic education rated wild spaces as more beautiful, and elderly people displayed relatively high preferences for managed natural settings. Contrary to the findings of Graca et al. (2018), we did not find gender-related differences in attitudes towards IGS.

Additionally, our research shows that street greenery makes cities more attractive. We speculate that this may be due to the fact that, unlike other locations, these areas are minimally managed by the city authorities (perhaps mown a few times a year), which is more often perceived as attractive (Özünger & Kendle, 2006). Additionally, street greenery protects against pluvial flooding (through retention of rainwater), which is a highly recognized problem in densely built-up city centers during rain events (Wagner & Zalewski, 2009). The answers indicated that the presence of trees on land parcels is particularly associated with noise reduction, temperature regulation and air purification, which may be due to the responders’ beliefs/feelings or the increasing availability and accessibility of scientific evidence. The findings are directly in line with research which provides evidence that urban trees reduce heat stress (Bowler, Buyung-Ali, Knight, & Pullin, 2010), noise levels (Nowak & Dwyer, 2007) and air pollutants (Escobedo, Kroeger, & Wagner, 2011; Nowak & Dwyer, 2007; Nowak, Hirabayashi, Bodine, & Greenfield, 2014). Furthermore, the presence of trees is related to respondents recognizing mental health benefits of IGS, which confirms findings of other studies (Gerstenberg & Hofmann, 2016). Additionally, species diversity is sometimes linked with a positive influence on the mental health of urban dwellers (Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007).

4.2. Suggestions for design interventions

Due to various constraints and barriers, such as lack of accessibility, limited local knowledge or acceptance, the cultural services of IGS, especially those related to recreation, are not fully exploited (Mathey et al., 2015). A similar conclusion was reached by our study, where people did not use these spaces for recreation and did not attribute them with educational and inspirational values. Since in many cities only cultural benefits make the presence of greenery formally recognized in decision-making processes, and thus protected under local plans, we consider suggestions for bringing these benefits to analyzed areas to be particularly valuable.

The most common suggestion from our respondents was to improve the orderliness of IGS, e.g. through better maintenance and tidying, to make them more inviting. This is in line with other studies showing a preference for manicured, neat and well-kept UGS (Özünger & Kendle, 2006) and an increased use of IGS, such as brownfields, if those were at least minimally maintained (Farahani & Mailer, 2019; Hofmann, Westermann, Kowarik, & van der Meer, 2012; Mathey et al., 2015). This preference for managed greenery rather than a more natural, wilder appearance was also emphasized in previous studies (Hands & Brown, 2002; Hofmann et al., 2012; Jorgensen et al., 2007; Laforteza et al., 2008; Todorova et al., 2004). The reasons given include dense, unmanaged vegetation, which translates into short viewing distances (Bixler & Floyd, 1997; Schroeder & Anderson, 1983), where vegetation interferes with surveillance (Jorgensen, Hightmough, & Calvert, 2002). This can be conducive to antisocial behavior such as dumping rubbish, violence, harassment and drug/alcohol consumption (Rall & Haase, 2011; Rink & Arndt, 2016). Several studies suggest that even minor maintenance interventions such as trimming vegetation (Rall & Haase, 2011; Unt & Bell, 2014) can reduce the perception of danger (Lindemann-Matthies & Brieger, 2016; Özünger & Kendle, 2006).

Our results make it clear, however, that suggestions for design interventions are highly dependent on the type of IGS, in particular its size, closeness to roads, tree coverage and type of management. In particular, unmanaged, large IGS located far from roads are frequently linked with a need to improve their functionality, safety and orderliness. The presence of trees increases the emphasis on tree-focused activities, such as pruning or planting, and on safety and clean-up issues.

Some respondents also suggested formalizing IGS and integrating them into the city’s existing system of green infrastructure, which could be beneficial to the long-term preservation of ecosystem services. These ideas are well-known and described in the literature (Brun et al., 2018; Kremer & Hamstead, 2015; Mathey et al., 2018).

4.3. Justifications for sustaining IGS in cities

Scarce greenery in city centers is significantly linked with a decreased life expectancy (e.g. Jonker, van Lenthe, Donkers, Mackenbach, & Burdorf, 2014; Takano, Nakamura, & Watanabe, 2002), increased morbidity (Maas et al., 2009), greater risk of allergies (Alcock et al., 2014; Ruokolainen, Fyhrquist, & Haahtela, 2016), cardiovascular and respiratory disease (Donovan et al., 2013) and higher obesity rates (Villeneuve, Jerrett, Su, Weichenthal, & Sandler, 2018). Contact with nature is known to influence mental health through lowering depression (Sarkar, Webster, & Gallacher, 2018), anxiety (Gascon et al., 2016) and stress (Pun, Manjourides, & Suh, 2018; Tyrväinen et al., 2014), improving concentration (Ottosson & Granh, 2006), and reducing aggressive and violent behavior (Younan et al., 2016). There are also a number of indirect effects of green infrastructure on wellbeing, emerging from regulating ecosystem services. Greenery in cities can help to cool the environment through evapotranspiration and shade provision (Bowler et al., 2010; Djeck et al., 2018; Kleerekooper, van Esch, & Salcedo, 2012), reduce noise nuisance (Dzhambov & Dimitrova, 2015; Li, Chau, & Tang, 2010; Van Renterghem & Botteldooren, 2016), and filter particulate matter from polluted air (Popek, Gawrońska, Szbő, Wroncha, & Gawroński, 2013; Przybylsz, Nersisyan, & Gawroński, 2019). Almost 84.5% of Łódź residents have highly limited access to any formal UGS. This has a twofold effect: it places existing high-quality green areas at risk of invasion of housing estates, and increases the
effects of eco- gentrification, making the most vulnerable communities more exposed to adverse effects of urbanization and climate change (Anguelovski, Connolly, Masip, & Pearssall, 2018; Klopowska, Laszkiewicz, & Kronenberg, 2020; Pearssall & Eller, 2020; Rigolon & Nemeth, 2020; Wolch, Byrne, & Newell, 2014). In both cases, IGS can serve as important planning alternatives, especially in cities where they are as abundant and widespread as in Łódź (Sikorska, Laszkiewicz, Krauze, & Sikorski, 2020). Their integration into spatial planning systems as new temporary or permanent green spaces can be a viable solution, potentially welcome by residents, who – as shown by our research – are aware of the impact such places have on their quality of life. Since cultural ecosystem services are co-created by people and ecosystems (Andersson et al., 2015), this is likely to set IGS in the city fabric by activities that promote their widespread use. A similar pattern of results was obtained by Mathey et al. (2018); their research into urban brownfields with spontaneous vegetation shows that in the case of re-development, spontaneous vegetation should be linked with aesthetic motives as well as traditional concepts of land management in order to meet the residents’ preferences for land use. This can lead to higher acceptance by local residents and help spatial planners to combine nature conservation and use of greenery (Mathey et al., 2018; Sukopp, 2005). Moreover, the changes requested by respondents in our research referred to relatively minor interventions that would not always completely change the nature of the site nor impose a burden on municipal services. Such balanced intervention can meet the requirements of both people and nature. Additionally, the suggestion to plant trees in places with scarce tall vegetation would improve biodiversity and regulatory services. Indeed, studies of the influence of revitalization of brownfields conducted by Koch, Bilke, Helbig, and Schlink (2018) show that re-development does not always lead to a reduction of i.e. cooling effects.

IGS can become areas which provide city residents access to greenery, improving their quality of life. Excluding them from development plans can be a critical element of environmental justice. Every aspect of intervention in urban areas takes into account their morphology as well as function and connectivity, and should be considered in a comprehensive way as a socio-ecological approach to transitions towards city sustainability (Krauze & Wagner, 2019; Kronenberg et al., 2017). In the Łódź example the majority of the respondents were in favour of preserving IGS after only minor interventions. Thus expectations were very modest and could be met at very low cost to the city. The claim raised as a response to the absence of alternative green areas in neighborhoods, and lack of other alternatives (private green spaces, opportunities to move out, or spend time outside the city). Consequently considering IGS in local plans would significantly improve living conditions of interviewed commuters, while simultaneously the interventions (cleaning, creating walking paths, benches) would have broader positive effect e.g. on vulnerable communities (elderly, children, poor). In the conditions of generally poor health status of citizens, exacerbated by effects of climate change, shrinking and aging population, and struggle with poverty and social exclusion, IGS seem to be the easiest, and the most economical way to create multiple benefits to society and nature-based insurance system. Lack of formal recognition of IGS creates a very fragile balance between green and grey infrastructure, questioning sustainability and adaptability of cities. During preparation of this paper two out of five studied areas have been already lost for housing development. It coincided with coronavirus outbreak followed by enclosure of all formal green areas – still located at half kilometers distance, and separated with barriers – busy streets and railways from study places). The situation became an eye opening event to residents of many city districts, whose daily activities got squeezed to tiny, overcrowded back and front yards. There is however no evidence of changes in the city spatial planning policy while many other European cities started to revise approach to IGS (Samuelsson, Barthel, Colding, Macassa, & Giusti, 2020).

5. Conclusions

- IGS in the Polish city of Łódź are perceived by residents as places able to provide a range of ecosystem services, especially those responsible for regulating ecosystem processes.
- These spaces are not used to their full potential at present; however, local residents have made suggestions for minor design interventions which should change this.
- The majority of suggestions indicate a desire for improving the attractiveness of IGS.
- IGS are important vegetated areas in the city which should be protected from being built on to complement formal green spaces in Łódź.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was carried out as part of the project ENABLE, funded through the 2015–2016 BiodivERsA COFUND call for research proposals, with the national funders The Swedish Research Council for Environment, Agricultural Sciences, and Spatial Planning, Swedish Environmental Protection Agency, German Aeronautics and Space Research Centre, National Science Centre (Poland – grant no. 2016/22/Z/NS8/00003), The Research Council of Norway and the Spanish Ministry of Economy and Competitiveness.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.scs.2020.102236.

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