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Research, part of a Special Feature on Holistic Solutions Based on Nature: Unlocking the Potential of Green and Blue Infrastructure

Mapping mental barriers that prevent the use of neighborhood green spaces

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ABSTRACT. In comparison to the study of green space use, the study of its non-use or rejection is greatly understudied. Neighborhood managers and members of local gardening initiatives of Halle-Newtown, Germany, state that residents ignore local green-blue infrastructure (GBI) for recreational use. Halle-Newtown is a former showcase, large prefabricated socialist housing estate that is now facing an increase of households deprived in multiple ways. We are interested in the question of why people of Halle-Newtown refuse to use local GBI. In order to uncover potential barriers to the enjoyment of the ecosystem service benefits of local GBI, we have chosen the method of mental mapping to explore place attachment in Halle-Newtown. In summer 2018, about 100 residents of Halle-Newtown described the places they prefer when relaxing from a stressful and hot summer day. The results were surprising. Local GBI, be it created in socialist times or recently, was completely absent from their mental maps. Instead, people would overcome longer distances and cover higher costs to reach central green spaces. Tacit knowledge, namely the untold general rejection of the entire neighborhood by the residents, was found to be the deeper reason behind non-use of GBI and missing place attachment. The results uncovered that both neighborhood neglect and the multi-scalar character of urban recreational ideas/behavior are factors that help us to understand non-use of urban GBI, two key insights for urban planning.

Key Words: *green-blue infrastructure; Halle; mental mapping; recreation; sense of place; tacit knowledge*

INTRODUCTION

Green spaces are among the most important open spaces in cities as they provide places for both physical and mental recreation (Rall et al. 2017). In addition to their function as part of urban nature and biophysical and food-web properties, urban green spaces (UGS) are key for ensuring and maintaining public health and human well-being (van den Bosch and Ode Sang 2017). UGS create a full range of ecosystem services (Haase et al. 2014), which can be used directly in place or as beneficial flows across distances (Andersson et al. 2020). For example, urban residents can enjoy air cooling directly under a park tree while the neighborhood also benefits from the fresh air the park vegetation produces. Thus, both place and proximity are, among other factors, key for enabling recreation through UGS.

Even though most cities in Europe currently face population growth and densification of the built space due to infill development in residential areas, they still report an increase in public green space, namely per capita and in total (Wolff and Haase 2019). As several recent research projects about UGS and nature-based solutions state (Kabisch et al. 2016, Pauleit et al. 2019), mainly for climate change adaptation, cities are investing in the enlargement and quality of UGS. This can be clearly seen as a kind of novel development in an urbanizing world, which still grows at costs of nature (McDonald et al. 2020).

In most of the cases, UGS benefit flows generated by novel green space come from intensively managed, party revitalized, parks, gardens, or leisure spaces, where design and management interpret nature as an easy-to-take bundle of benefits for visitors/residents (Haase et al. 2017, Andersson et al. 2021).

Conceptual thoughts on mental space of a city

However, the growth of green spaces often produces partly unintended new injustices and unfair access to prevailing and new green spaces (Anguelovski et al. 2020, Langemeyer and Connolly 2020). Thus, and in line with what Andersson et al. (2019) have reported, the recreation and well-being that urban residents can enjoy from UGS—here understood as ecosystem services benefits flows—is decisively dependent on both its quality and the distributional pattern of UGS, on the one hand. On the other, the city as systemic body (Ernstson et al. 2010, Ernstson 2013) provides some more prerequisites that enable the enjoyment of UGS benefit flows:

1. Urban infrastructure including the physical and material composition of the city and its configuration (ecological and technical infrastructure according to the social–ecological–technical/built system (SETS) concept of McPhearson et al. 2016).
2. Urban institutions including different forms of human agency in the city including offices, municipality departments, civil society, rules, and norms.
3. The urban "mental landscape," which includes all the different capacities, understandings, and individual perceptions that urban residents possess and express in relation to their perception of UGS benefit flows (the second and third belong to social infrastructure according to McPhearson et al. 2016; Wolff, Mascarenhas, Haase et al., *unpublished manuscript*). Andersson et al. (2021) call these capacities filters, and state "each [SETS] filter is understood as having both direct, individual effects, and a combined interactive effect on the flow and distribution of benefits."

Understanding filters as factors of non-use of (green) spaces (Dallimer et al. 2014, Boyd et al. 2018) is crucial for better UGS planning and management and for the design or facilitation of conditions under which people feel attracted or not to the green spaces of the city. A study about adults in England found that deprivation and the quality of the neighborhood greenspace affected interest and visitation frequency (Boyd et al. 2018). Another study carried out in urban England, in Sheffield, found socio-demographic characteristics of the urban dwellers such as

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income, age, or gender less suitable predictors compared to biophysical attributes of greenspaces when looking for determinants of use frequency (Dallimer et al. 2014). For Brisbane, Australia, a survey study found nature orientation as key determinant of and for (longer) park visitation (Lin et al. 2014) whereas Lee et al. (2001) report, similar to Dallimer et al., multiple deprivations as core predicators for outdoor-recreation in urban regions in Texas.

Following both the ENABLE filter and barriers approach (Biernacka and Kronenberg 2018, 2019, Biernacka et al. 2020) and the above referenced literature from different cities at different continents, we hypothesize that (biophysical) space, household characteristics, and place-related cognitive factors (perception filter[s]), next to design (infrastructure filter) and management (institutions filter), could be reasons for the non-use or even refused-use of local green spaces; we label these factors mental barriers. The basic idea for this study assumes that implicit knowledge together with personal affinity to a place are key for understanding these mental barriers. First, personal affinity is one important component of the sense of place concept (Stedman 2002). A sense of place is a multidimensional, complex construct that is used to characterize the relationship between people and spatial settings/contexts (Casey 2001).

Thereby, mental mapping is a way to draw internal/individual images to either construct or reflect spatial contexts and their meanings in our surroundings (Stedman 2003). In cities, these surroundings can be the residential neighborhood or the district we live in. Mental maps develop as we get to know what is around us, both near and far, small or big, explicitly and implicitly (Fazey et al. 2006). Mental maps help us to navigate around, to organize information to recall later, and to create meaning, for example, the meaning of UGS at place (Stedman 2003). For instance, places within a person's neighborhood are most visited or the corresponding person has detailed knowledge about the spatial entities close to her or his home. Second, expressing and accessing the individual relationship between an urban resident and the local UGS—returning to our example—has many implicit facets. Implicit knowledge is the part of our knowledge that cannot be articulated (Fazey et al. 2006); it is tacit. We follow Duguid (2005) arguing: "Championing the explicit to the exclusion of the tacit may threaten to take us back, not forward" (p. 111). Mental mapping is one way to make this implicit knowledge (about the human-place relationship) explicit (Fazey et al. 2006, Raymond et al. 2010). From a more spatial or geographical perspective, we attempt to link the aforementioned urban residents' knowledge and perceptions with one of more elements of the urban space (as discussed in the article by Sowińska-Świerkosz et al. 2020).

Applying the concept to the case study of Halle-Newtown

Here, the case study of Halle, Central Germany, comes into play. Halle has been growing at a moderate pace in the last decade after a longer period of shrinkage that was due to population loss (Haase et al. 2017, Nelle et al. 2017). Today, the city has 240,395 inhabitants and belongs to the industrial and cultural heart of Central Germany (Table 1). Geographically, Halle is traversed by the river Saale and its remarkable floodplains, a composite of remnant broadleaf forests and diverse fluvial meadows. The Saale floodplains make up the largest green space in the city and consist of several parks, nature protection areas, and leisure spaces.

Table 1. Basic information for the city of Halle and Halle-Newtown as the case study area for data collection (own compilation based on Halle census and municipal statistical data).

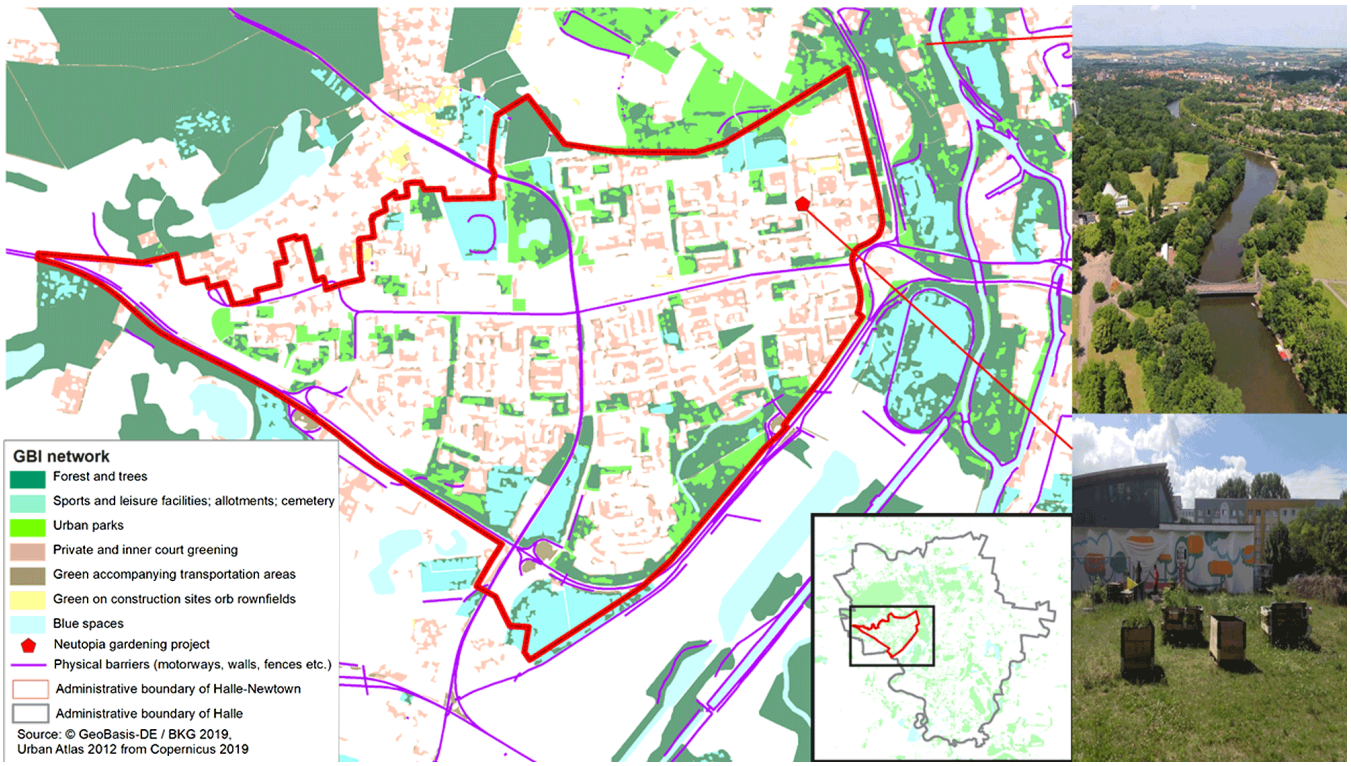
	Halle	Halle-Newton
Population 1989	230,728	91,563
Population 2019	240,395	45,632
Population balance	9,667	-45,931
Net migration (2019)	230	112
Mean household size	1.75	1.98
Share of single parent families	3.2%	6.8%
Share of retired people	23.4%	25.1%
Population density	17.85	67.12
Green space (area in ha)	560	142
Per capita green space (m²)	23.29	31.22
Employment rate (2019)	6.1 %	12.4 %
Mean age	44.8	46.1
Average income level (2019), in €	16.044	14.771

Next to the old center, Halle comprises one of the largest prefabricated socialist housing estates of the former German Democratic Republic (GDR), Halle-Newtown (Fig. 1). This district presents a complex and complicated pattern of the three filters: infrastructure, institutions, and perceptions (Andersson et al. 2019). With a remnant elderly population that moved there in socialist times along with a current increase of multiply deprived households (low-income, migrants), neighborhood management states that local residents ignore local UGS for recreational use regardless of whether these spaces are "old-type" GDR creations or completely newly built, as mentioned above.

Fig. 1. Image of the Halle-Newtown case study area. Most of the prefabricated houses have been renovated, at least partly, however, the image of a monotonous and uninteresting place developed after 1990 and remains today (Source: http://www.halle.de/en/Home/index.aspx)

As Table 1 reports, Halle-Newtown faced an enormous population decline after German reunification in 1990 and is still catching up. Today, this part of the town is the most precarious,

Fig. 2. In its upper section, this figure shows the green-blue infrastructure (GBI) network of Halle, in particular, the central Saale floodplains and Halle-Newtown in the west including the Neutopia community garden with its planting boxes. The pink lines stand for strong physical barriers (roads, tram rails) and the river Saale. The pictures on the right provide an impression of the shape of the GBI in the Saale floodplains and Halle-Newtown (Figure by Manuel Wolff).



with double the unemployment rate when compared to the city as a whole, but also the most diverse in terms of nationalities and household income spread (Gorn et al. 2018). At the same time, underprivileged households are settled in Halle-Newtown that include low-income and single parent households and migrants, among which there are many asylum seekers (Arnold et al. 2018). The share of this migrant population has increased from under 5% to more than 20% in under a decade (Halle census and municipal statistics 2020).

Halle-Newtown is a comparatively green neighborhood that contains an above-average green space provision of > 30 m² per capita. Because of its peripheral situation in the west of the city, Newtown is comparatively minimally impacted by high traffic pollution and car traffic as such. In terms of design, one major road, according to our concept a techno-physical infrastructure filter, divides the neighborhood into northern and southern sections. Green spaces can be found all around the neighborhood (Figs. 1 and 2) and are often straightforwardly accessible. Linking this spatial context to the argument above, that Halle-Newtown is home to many low-income single parent families and retired households, both groups should benefit from the flows of ecosystem services provided by such well-distributed green spaces. However, planners and neighborhood managers reported in interviews and joint discussions that people either do not use the local green spaces offered, be it neighborhood parks or a community garden recently established (http://gartenwerkstadt-halle.de), or do not know where new green spaces have emerged in the last decade.

Objectives

To discover why this situation of UGS non-use or rejection exists, we intend to use the reflection exercise as a way to reveal the mental barriers of Halle-Newtown residents concerning their use and non-use of the local UGS. Therefore, we have chosen the method of mental mapping. This method has the advantage of not influencing respondents in a way that they feel forced to mention expected locations. Rather, this method allows, to a certain extent, to capture tacit knowledge (Bharwani 2006, Raymond et al. 2010), which can then be translated into findings that help to archive the following sub-goals in line with our assumptions:

1. Detecting how local residents perceive, construct, and reflect their direct environment and/or neighborhood using mental maps.
2. Understanding which local or citywide UGS Halle-Newtown residents perceive and use.
3. Using mental maps to identify barriers for the non-use/rejected use to draw conclusions for both accessibility and attractiveness of UGS in Halle-Newtown and the entire city.

In the best case, the results of the study will help us better understanding the perception filter(s) that either enable or disallow these people from benefitting from UGS ecosystem service flows. What is more, the results should provide insights for local urban planners and UGS governance actors so that they can more specifically evaluate the current planted and successive vegetation patterns (biophysical infrastructure), their design, and their context.

MATERIAL, CONCEPTS, AND METHODS

Concepts and hypotheses

In order to uncover potential mental barriers and, if possible, to attribute the perception filter introduced above, we made use of two concepts that link UGS elements with both reflections and emotions of residents (Lengen and Kistemann 2012, Dallimer et al. 2014).

"Sense of place," the first concept, is useful because it (a) presents a descriptive approach, (b) focuses on place meanings, and (c) provides an appraisal of what is found/reflected at a place, something that is called "place attachment" (according to Stedman 2003, Masterson et al. 2017). Sense of place and respective place attachment fold together material characteristics and symbolic meanings for a specific place (Stedman 2002, Raymond et al. 2010). Place attachment is thus deeply grounded in either personal experiences, or factual or physical settings at a site, or are created by institutions and hierarchies responsible for designing/arranging the place (Stedman 2003). In our case, the place(s) of interest are the UGS (and the ecosystem services [ES] benefits) of Halle-Newtown.

"Tacit knowledge," the second concept, is subconscious, usually hidden, and publicly unrepresented information (Bharwani 2006), which can be accessed with mental mapping as one of the empirical methods (Raymond et al. 2010). Tacit knowledge, as opposed to formal, codified, or explicit knowledge, is that kind of knowledge that is difficult to verbalize, state, or write. For uncovering potential emotional or perception barriers in a public environment, the concept of tacit knowledge is particularly relevant because it represents personal knowledge obtained as a result of the direct interaction between individuals, in our case the residents of Halle-Newtown, and their environment (Raymond et al. 2010). We judge tacit knowledge to be a reservoir of intangible resources from which planners can gain thus far unknown and untold but key knowledge that can better shape and manage UGS in their city. We connect the conceptual frame described in the introduction and here with the mix of methods introduced thereinafter and applied in the field using three assumptions that allow to conclude on a person's affinity to a place:

1. A rather simple and straightforward mental map of a resident's neighborhood indicates the existence of mental barriers.
2. Focusing on locations or objects outside their own neighborhood point to the non-use of the mentioned UGS places by a respondent.
3. Recommendations given by residents that point to locations that should be avoided point to the refusal of the mentioned UGS places by a respondent.

Accordingly, we applied three methods framing the core method of mental mapping: typification of mental maps, GIS mapping, and accompanying interviews.

Mental mapping

In behavioral geography, a mental map is a person's point-of-view perception of her/his area of interaction (Gregory et al. 2009). By representing residents' relation to and perception of specific places with mental maps, a local perspective can be captured, which M. Tengö et al. (2014) stated to be a means for approaching green infrastructure and ecosystem service-related topics.

Practically, we carried out a mental mapping (n = 100) study to identify problems at the individual level that are related to images, perception, and behavioral aspects (Schumacher 2018). We approached residents at five central locations in the neighborhood of Halle-Newtown (tram stop, in front of the central shopping mall, in front of the supermarket, playground, and foreground of a primary school). If potential respondents were not attracted by the question they were not included in the sampling as typical for many other field sampling methods.

When residents agreed to participate in the mapping, we asked them to sketch their ideas of the places that they seek for physical and mental recreation on hot and stressful summer days and to draw how to they travel to these places (Fig. 3). The imagination of a hot summer day refers to (a) one of the most common and important reasons why people visit green spaces in cities (Haase et al. 2014, Kabisch et al. 2016), and (b) because the summer in 2018 was hot and dry, and we assumed people would remember this well, that this trigger would help them to draw more clearly. Pen and paper were provided. The sketching was fully anonymous. There were no time constraints when drawing.

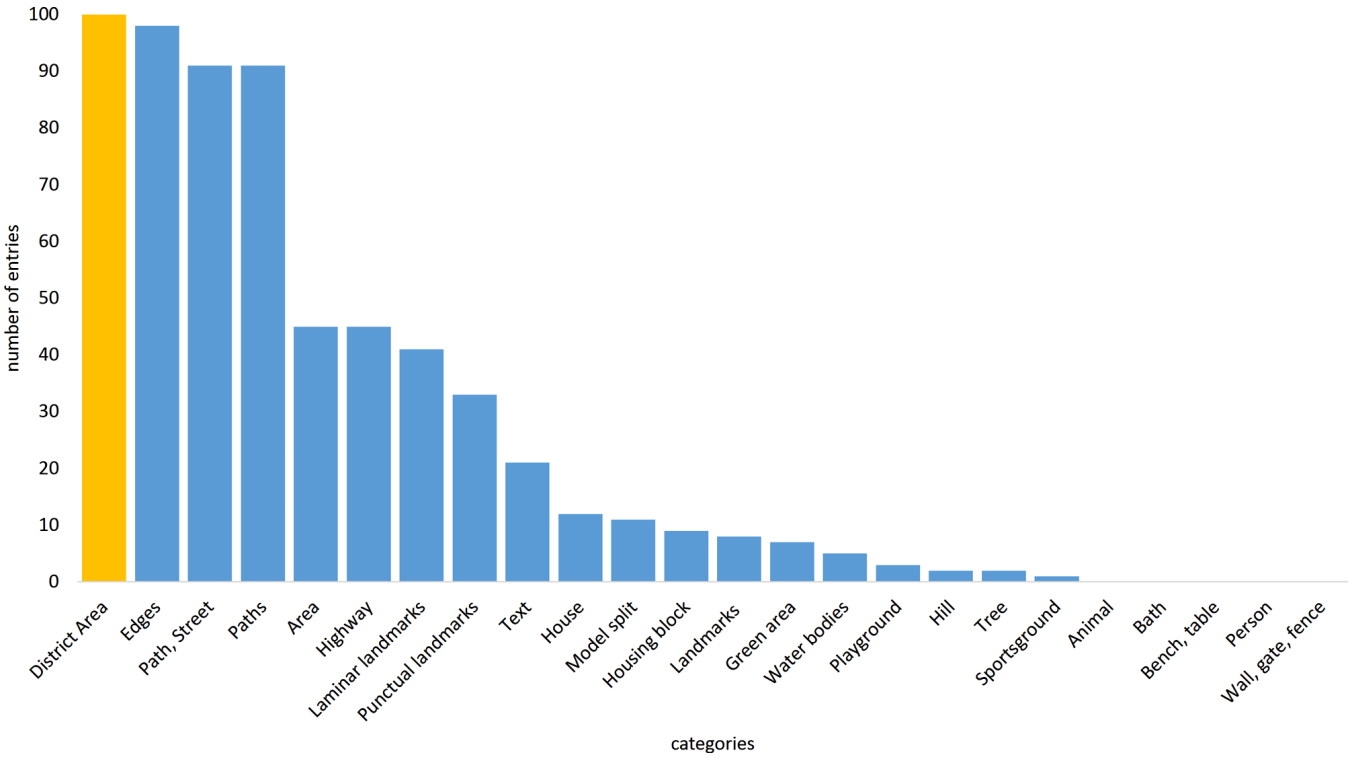
Fig. 3. Mental mapping exercise design in the field (own sketch).

Types of mental maps

For the first step of analysis, we decoded and read the maps. We interpreted the sketches that included the recognition of the sketched elements, counting them and interpreting relationships of size and distance and what was omitted etc. In particular, we identified both descriptive and cognitive elements in the residents' sketches (mental maps) such as UGS elements, recreational, food supply, and transport infrastructure, landmarks, etc. First, these elements were quantitatively analyzed in form of descriptive statistics. Second, we developed types of appraisive and designative categories in the form of narratives that classify mental maps based on the quantity and quality of the drawn elements (typification; Table 2).

Both categories were developed in existing mental mapping studies (see Gillespie 2010, Larsen and Harrington 2016, as cited

Fig. 4. Frequency of the sketched elements in the mental maps classified in the (adapted) appraisive and designative categories according to Gillespie (2010) and Larsen and Harrington (2016), as cited in Otto (2018); differences between the first four categories and the rest are significant at p = 0.05 level. Laminar and Punctual landmarks, laminar = axis-like; punctual = point-like.



in Otto 2018). After a preparatory review of the mental maps received, the categories were adapted to the empirical data and context of the case study. The appraisive category system targets the interpretive, appraising characteristics of neighborhood features (be they landscape, built, or technological) that are drawn in the maps whereas designative categories ought to classify elements by focusing on their spatial substance and design (Larsen and Harrington 2016, as cited in Otto 2018, Gillespie 2010; Table 2).

GIS mapping and statistical analysis of the results

A GIS-database of UGS in Halle was established using existing publicly available spatial data (Urban Atlas, Open Street Map, ATKIS German Topographic Information System) on public green spaces, street, and park trees. We mapped more general land use/cover (changes) in 2018 that allows to identify several off-site, boundary, and on-site physical barriers of and along UGS as expressions of physical infrastructure filters across the entire city. However, a comparatively low number of these were found in Halle-Newtown (an extra study by Barber et al. 2021; Wolff, Mascarenhas, Haase et al., *unpublished manuscript*). The elements of the mental maps were classified according to the categories displayed in Table 2 and analyzed according to how their frequencies were analyzed (cf. Figs. 4 and 5). Finally, all categorical counts were added to our green infrastructure database (GIS database) as additional attributes in another column.

Fig. 5. Different types of mental representations of green-blue infrastructure (GBI) users in Halle-Newtown: Type A (upper left) refers to the origin and destination of the walk/way; Type B (upper right) focuses much more on details like shopping facilities, a streetlamp, and a bench; Type C (lower left) entered all street names describing the walk/way with particular focus on the riparian Peißnitz Island; whereas Type D (lower right) represents those respondents who have drawn map-like representations.

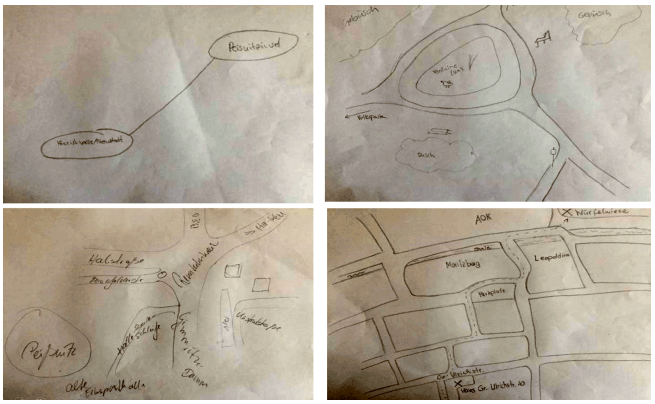
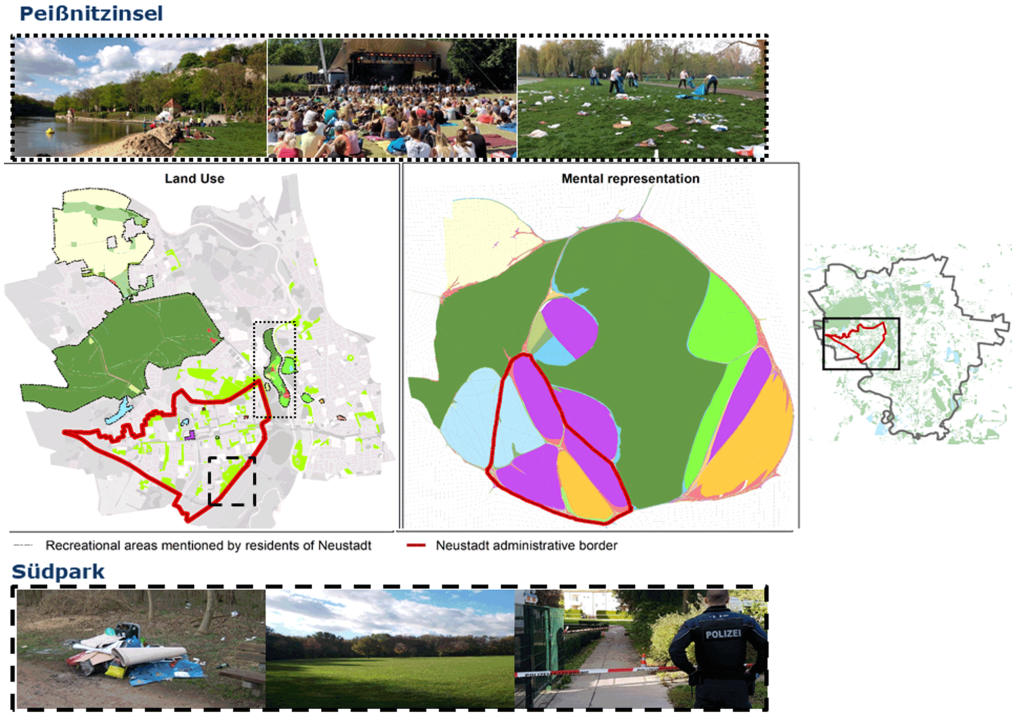


Fig. 6. The central section of the figure shows, left map, the real situation and distribution of the green-blue infrastructure (GBI) network in both places, Saale floodplain and Halle-Newtown and, right map, the mental representation of the most important green spaces of the Halle Newtown residents, as discussed in the text and resized by the number of entries. Halle Newtown and its GBI appear much smaller in this synthetic mental map when compared to the Halle Saale-floodplains GBI. The pictures in the lower section explain why. The boxes refer to the photo bars above and below the two maps and the needled box refers to the Klausberge (in German: Klaus Mountains) some of the respondents referred to and the dotted box to the central Peißnitz island we talk about in the preference and MM analysis (Layout: Manuel Wolff).



Afterward, using the number of entries per category, the spatial representation of all UGS elements of Halle that were mentioned by Halle-Newtown residents in their mental maps were "resized" in their geometry using the "ScapeToad Representation Toolbar" and mapped using the UGS categories we used for green space mapping (Fig. 6). The method behind this is a manual construction of continuous cartograms through algorithms of mesh transformation (Kronenfeld 2018). This allows the comparison of the existing UGS and the UGS setting mentioned by the respondents. Distinguishing between UGS within and outside the district of Halle-Newtown allows to illuminate on our research questions.

Interviews

Most of them provided additional verbal explanations after finishing the sketch, however, oral interviews did not strictly belong to mental mapping itself. Although non-systematic, they are important additional sources of information for the interpretation of our empirical findings. People were asked first if they live in Halle-Newtown, and second if they could indicate a UGS to be avoided. In addition, the following socio-demographic characteristics were recorded: gender, age class, occupation.

Framing methods

The mental mapping study was framed by a quantitative and GIS-based study of the UGS infrastructure in the form of pattern, ecosystem flows, and benefits (see methods collection for the ENABLE case studies in Andersson et al. 2021), as well as a study of socioeconomic profiles of the (potential) beneficiaries (using census data). Experts in urban planning as well as neighborhood initiatives were consulted for an assessment of the actual UGS in the city as well as new and future developments of UGS, particularly in Halle-Newtown. We carried out an extensive literature search of scientific articles and, most of all, of grey literature and policy documents for Halle. In addition, we conducted an online document search and analysis that included social media, online blog entries, and websites of different UGS related projects in and around Halle. This helped us to develop a broad knowledge base of the UGS activities and the local policy discourse about local neighborhoods in the city of Halle, especially of Halle-Newtown. To identify/uncover problems and failures of UGS projects at planning and governance level, we conducted a series (n = 15) of in-depth interviews with stakeholders to identify institutional filters of or for UGS ES benefit flows.

RESULTS

Setting the scene: UGS in Halle

Mapping of the local UGS in Halle shows that about 16% of the total area of the city is recognized as green or blue space, in our case UGS, including 560 hectares of public parks, 120 hectares of street green (trees and shrubs), and 546 hectares of allotment gardens. There are hardly any community gardens present in the area. Halle hosts more than 25,000 street trees and 16,000 trees in parks and other public green spaces. The surroundings of the city are dominated by pasture and agricultural land uses.

We further found that UGS is not equally distributed across the city, with the largest public green areas situated in the southeast, including the Elster-Saale-Floodplains, the nature conservation area of Raven Island, and the highly biodiverse Dölau Heathland in the north. Salt mining over centuries diminished forestland in the region so that Halle is particularly poor in forest land use. New plantations as follow-up land use in the former socialist prefabricated housing estate of Halle-Silverheight almost completely failed (Vollrodt et al. 2012). As the river Saale and its floodplains cross the city's center, the overall accessibility of the central UGS is generally given and urban planners clearly focus on new pedestrian bridges for cyclists and walkers to guarantee and improve this accessibility (Barber et al. 2021).

Field observations and walking interviews with local experts in Halle-Newtown shed light on current developments such as the implementations of new green spaces including gardens, playgrounds, and small greened lots and planning that aims to create more inclusiveness in a deprived and low-income neighborhood (Schumacher 2018). Once a showcase of the GDR as a comparatively green mixed socialist neighborhood dominated by prefabricated housing estates, today, Halle Newtown's green spaces, which still appear to be very green, are quite neglected and not particularly welcoming. A new community garden and neighborhood management actions involving UGS are attempts at lowering the barriers between the neglected groups in the neighborhood and between Newtown and the city center, so far with limited success (Rösner 2019).

Seen through the eyes of an inhabitant of Halle-Newtown, enabling equal access to recreational functions of UGS in the city of Halle is hampered by physical and infrastructural barriers (see also Kronenberg et al. 2021; Wolff, Mascarenhas, Haase et al., *unpublished manuscript*). At first glance, transportation infrastructures and other physical barriers—offsite such as major roads or distance, boundary such as fences, walls, entrance fees, or onsite such as missing waste bins, benches, light or shadow, as well as rubbish, food leftovers, and drug injecting equipment—seem to be potential candidates for obstacles to the use of local UGS. Lack of finance is not a large problem because the budget is provided by the city council to support UGS in Halle-Newtown, as Rösner (2019) found in another local study about institutional barriers in green planning and land management of Halle.

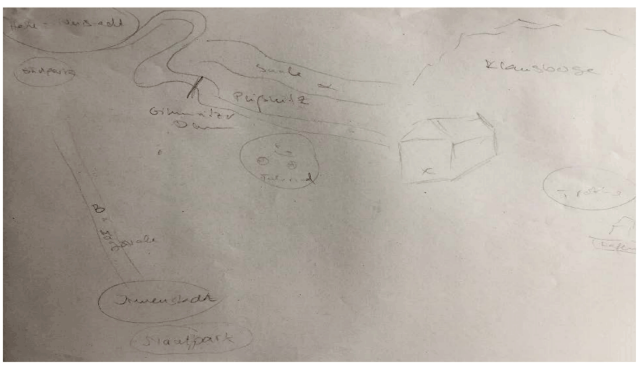
Entities, objects, and types of mental maps

The empirical results of the mental mapping exercise that was used to uncover cognitive barriers in green space use that were linked to mental constructions of both sense of place and tacit knowledge, were surprisingly clear. First and foremost, it needs to be stated that interest in participation in the sketching exercise was high (Schumacher 2018). Over 100 Halle-Newtown residents participated and, overall, 100 sketches came together for interpretation. People felt capable of drawing their answer to our question "where do you go to relax on a stressful summer day?"

Figure 4 presents the quantitative results of the study, displaying a histogram of all entries that could be identified in the maps that use (adapted) appraisive and designative categories, according to Gillespie (2010) and Larsen and Harrington (2016), as cited in Otto 2018. At first glance, there are four (designative) categories that dominate the chart (significant at 0.05 level): district area, edges, paths, and streets. Appraisive categories that include green area or trees were sketched less frequently by the Halle-Newtown residents. The mention of streets as one important element explains that linear transportation structures are perceived and reflected by the respondents. However, as a representative selection of sketches in Figure 5 show, streets are not reflected or mentally constructed as barriers to reach local UGS but rather as opportunities of access to more distant UGS that respondents seek to travel to as they are more/most attractive to them.

As outlined in the introduction part of the paper, another aim of this study was to analyze what type of descriptive and cognitive characteristics and properties of the recreational environment have been sketched by our 100 respondents. Figure 7 reveals some details of how residents mentally represent their direct environment or neighborhood (as introduced by Bell 2009). The mental maps here largely differed from one another except for the fact that they did not refer to the local neighborhood of Halle-Newtown.

Fig. 7. Original mental map selected from the Halle-Newtown sample (n = 100).



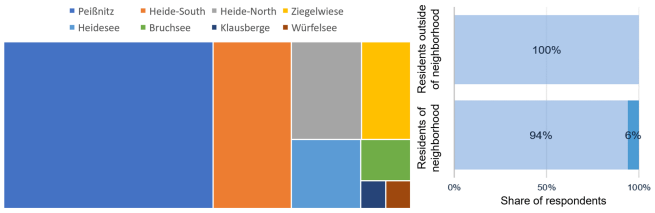
Most maps are rich in material elements and pictograms of landmarks, lakes, islands, floodplains, or trees. Features of the built environment and nature were both addressed in accordance with a categorization system that has been introduced in existing mental mapping study (Gillespie 2010). Some sketches give away quite clearly perceived physical elements of or for UGS accessibility, and this addresses the infrastructure filter. They are not necessarily drawn as physical barriers but more as access ways leading to the UGS that the respondents are interested in; this is at least our interpretation of the linear elements in many maps. Smaller elements of UGS, such as trees, play a minor role (n = 2) in most of the sketches and, if present, perform a very functional role that indicates orientation and the variety of accessibility

options rather than place attachment (two very distinct meanings of green according to Brown et al. 2015).

Non-use and mental barriers

Figures 6 and 8 both provide further clear evidence that none of the respondents listed any UGS structure/place in Halle-Newtown except for the central floodplains and its parks (> 60%), the more distant northern heathlands (~30%), and three lakes (10%) in the surroundings of the town. Their own neighborhood, including its prevailing and new green spaces (parks), does not appear although Figure 4 clearly shows that there are many smaller parks in the neighborhood. In general, there was no difference between people coming from Halle-Newtown or not: the majority of respondents mentioned UGS outside of the district.

Fig. 8. Frequency of urban green spaces within and beyond Halle-Newtown mentioned in the 100 mental maps.



All identifiable and countable UGS features were entered in the UGS map mentioned above and resized according to the entry-frequency number. Thus, the shape and size of the original GIS patches changed and adapted to how often this patch was mentioned by the participants (Fig. 6). The resized map has been enriched by some photographs of both the "preferred" but distant UGS of the Saale floodplains (Peißnitz Island) and the "refused" but close UGS of Halle-Newtown (South Park in our example).

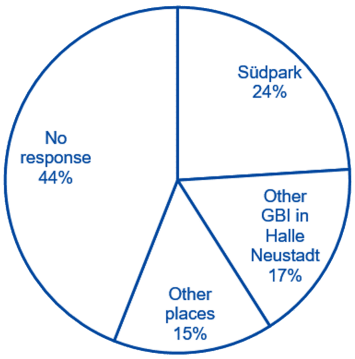
Responses and personal narratives

Respondents commented on their sketches in many cases with a regret that they currently "have to live" in Halle-Newtown but assured that they are very likely to move to the "right" side of the floodplains, to Halle town. These narratives were conveyed by respondents of all age classes as well as by female and male residents. Because the narratives were not part of the mental mapping exercise, strictly speaking, but rather voluntary information revealed by those interviewed, we cannot provide an analysis of any statistical significance or similar measures here. To lower the barrier of participation, which was our focus, we did not collect any personal information from the participants.

Figure 7, already earlier introduced, provides an interesting detail of the study in the form of one mental map that shows the "dilemma" of UGS non-use in Halle-Newtown. In this example, the neighborhood is mentioned in the upper left as a kind of starting point, but the floodplains and the central city park are centrally drawn as well as the way to go there. In this sketch, the Klaus Mountains are also mentioned, as well as parts of a quite distant sunny heathland. These were not locations that we as researchers assumed people would seek to travel to for daily recreation.

Finally, asking which UGS are to be avoided most respondents mentioned, if they mentioned any, the South Park (in German, *Südpark*), which is the largest green space within Halle-Newtown. The South Park was a popular recreation destination in socialist times but its popularity decreased along with that of the whole former industrial workers' neighborhood after the German Reunification in 1990. Reasons for today's non-use are, based on field observations and debates with stakeholders, a feeling of being neglected and of insecurity together with a feeling of being disturbed or excluded by other socio-demographic groups (Fig. 9; Wolff, Mascarenhas, Haase et al., *unpublished manuscript*).

Fig. 9. Urban green spaces visitation and non-visitation according to the 100 mental maps. GBI = green-blue infrastructure.



DISCUSSION

Mental maps serve, in this study, as an unexpected momentum: The maps produced by the local residents show that there is no real place attachment at all for local UGS in Halle-Newtown, which was somehow expected when setting up the study and as outlined in the first part of the article. Accessing the reasons for that in the form of tacit knowledge is challenging but doable, and still allows to conclude on the role of the characteristic and image of the whole neighborhood for the non-use or refusal of using UGS within their own district. Thus, the combination of the two concepts, sense of place and tacit knowledge, enabled us to develop an interpretation of what might be masked by the sketched non-use/refusal of local UGS and its benefits to Halle-Newtown residents.

The non-place-attachment provided explanatory power, which is, rather casually, mentioned in the references that are used to introduce the sense and use of place concepts (Stedman 2002, 2003, Lengen and Kistemann 2012, Dallimer et al. 2014, Raymond et al. 2010). The 100 mental maps we collected in Halle-Newtown do not reveal lots of details of the descriptive or symbolic meaning that people ascribe to UGS and its features in the neighborhood but, instead, tell us about the untold and deep-set rationales behind this missing of details about neighborhood UGS.

The mental maps we received in our study tell us that the respondents we met and asked in Halle-Newtown are majorly attracted by non-local but citywide, central green spaces and long-established UGS, for example, the central Saale wetlands, the Peißnitz Island, and some peripheral headlands. These spaces by far outweighed existing or soon-to-be created UGS in the respondents' own neighborhoods, which are much closer, just

around the corner for most of the Halle-Newtown residents. The different types of mental maps have shown that respondents have a different mental representation of their environment and, consequently, a different place attachment. Furthermore, the active refusal of the neighborhood's largest green space, the South Park, shows that it is not just the quality or attractiveness of green spaces (Voigt et al. 2014, Biernacka and Kronenberg 2018) outside their own district nor the different degree of place attachment, but to a larger extent also the overall quality and attractiveness of the neighborhood itself, which push residents toward using alternative areas for recreation, which is in line with what Lee et al. (2001) found for Texas and Dallimer et al. (2014) for Sheffield, UK, both regions with industrial background like Halle. Using both concepts, sense of place and tacit knowledge, enabled us to uncover and understand the at-first imperceptible underlying reasons behind the negative-positive antipode-like UGS perception that has been constructed by obviously many Halle-Newtowners.

Deep-set reasons for mental barriers and links to environmental justice

There is a rather fundamental scale "jump" in each of the maps. Named and unnamed features on the mental maps reveal the overwhelming dissatisfaction of the Halle-Newtown residents with their own neighborhood. This dissatisfaction is not exclusively directed toward the green infrastructure but also the parks and gardens there. A typical response from the participants in the mental mapping exercise was something like: "I am actually from Halle and this is where I go for recreation. I only accidentally live in Halle-Newtown now" (Map 13), or "I only live here temporarily. I plan to move to Halle city center very soon." (Map 88). The mental barrier, which we conceptualized in the ENABLE project (see Andersson et al. 2021; Wolff, Mascarenhas, Haase et al., *unpublished manuscript*), exists but does not refer to single or specific features or qualities of the UGS in Halle-Newtown. Rather, the reasons are causally related to both character and image of the district.

The story told by the sketches of the respondents in this paper covers a long period that includes Halle-Newtown's history as a socialist showcase development up to its current position as a district of many low-income and otherwise deprived households as well as an arrival places for migrants since 2015. Because of the obvious refusal and non-use of local UGS that is revealed by the mental maps, we hypothesize that the mental barrier of UGS non-use we uncovered is a result of hybrid factors: the socialist legacy, on the one hand, and the comparatively drastic decline of the district, on the other. Both factors are comparable with factors listed by Dallimer et al. (2014) as reasons for non-use of UGS: green space neglect and self-reported well-being. These factors, together, produced an involuntary relationship between residents and the neighborhood itself (see Draus et al. 2019 for similar phenomena in Berlin and Detroit). This is what environmental justice studies call a typical narrative. It is about procedural, not necessarily distributional, and interactional justice (Low 2009, 2013). Interactional justice lies in the negative "looser" image that is attributed to the district by a wider unspecified public. Procedural injustice is cause by the continuous insensitive accumulation of problematic households in the district by the municipality.

Policy implications of the uncovered mental barriers

The case of Halle-Newtown and its prevailing and novel green spaces/community gardens raise the general question of the role of greening in deprived urban neighborhoods (Curran and Hamilton 2012, Haase et al. 2017). Here, the prevailing best practice of UGS co-development, implementation, and improvement strategies, which successfully work in better-off areas, meaning middle-income and high-income neighborhoods, seem to fail and the claims of city planners cannot be met (Cucca 2012).

As part of the Halle greening strategy, new UGS was created, with proper institutional support, which aimed at influencing the inhabitants' perceptions. However, this greening strategy failed as a stand-alone measure. It did not consider the above explained procedural and interactional injustice between Halle and Halle-Newtown and, in particular, the spatial isolation of the single-parent families, unemployed people, and migrants from many different origins. What do we mean by failed? UGS benefit flows are present but the respondents do not perceive them. The neighborhood inhabitants reject UGS because it is in the neighborhood.

This brings us to another interesting link between the results of our mental mapping exercise, the place rejection that was revealed in Halle-Newtown, and the phenomenon of public ignorance of entire neighborhoods in cities (Grossmann et al. 2017, for Halle-Newtown's twin city Leipzig-Grünau). Based on our interpretation of the mental maps from above for Halle, we find a mixed kind of trauma that merges the post-socialist past with a rapid and strong social segregation (by income, education, and reputation) after 1990 (Großmann et al. 2015). In this sense, Halle-Newtown includes both built remnants of the wall fall/reunification trauma, prefabricated housing stock, and the social decline trauma (see again Draus et al. 2019) that is the result of rapid mass-unemployment and being forced to move or stay in the built socialist past. This creates a symbolic sense of place, but a very ambivalent one (Steinführer and Hall 2011). Here, the ENABLE case study of Halle-Newtown can add novel knowledge. Trauma arising from emerging and ongoing residential segregation also impacts UGS benefit flows and reduces accessibility, or delivery, according to Biernacka and Kronenberg (2019), in a figurative sense and despite proper availability at the neighborhood level (Biernacka and Kronenberg 2018, Biernacka et al. 2020). Municipal institutions lack ideas about how to alter this situation while they prepare to increase the accessibility of the floodplains UGS.

Urban planners should not just focus on creating better physical connectivity for existing UGS at multiple places, first between the central Saale floodplains and the Newtown, and, second, between green spaces within the local district. They should, furthermore, pay more attention to aspects of cleanliness and safety at UGS locations in Halle-Newtown. A broader participatory discussion shedding light on the complex phenomenon of "self-reported mood and feeling underprivileged" could help to jointly uncover and thus, eventually, lower mental barriers (see again Dallimer et al. 2014). This co-uncovering of perceived or self-attributed deprivation, be it in line with factual deprivation (low income, poverty, low education, powerlessness) or not, should be the priority for UGS planning in Halle, at least for a period.

Method limitations and transferability of the results

Compared to participatory spatial methods/tools like participatory Geographical Information System (PPGIS; see Rall et al. 2017, on cultural ES in Berlin), which support sharing personal experiences and information (using predefined topical quantities and qualities) into a web-based geographical map, mental mapping does not require any predefined categories or classes and exclusively relies on how a person reproduces knowledge about a place and on the drawing capability of this person (Matei et al. 2001). Consequently, it is an excellent tool for assessing tacit knowledge of respondents in terms of a specific spatial entity. This means that spatial information can be depicted according to its daily experience and perception. In this way, the importance of certain parts of an area, in this case the importance of the UGS, can be revealed for certain groups together with its use, identity, and appreciation. Mental mapping does not require specific or advanced language skills with certain groups, e.g., elderly or foreign people being also able to draw or sketch.

However, mental mapping demands certain drawing and cognitive skills from the participants, such as spatial vision, spatial orientation, memory of spatial elements, directions, or distances. The respondents' drawing can, to a certain extent, influence the result, e.g., the level of details within the sketches. Complementary questionnaire methods or recording verbal descriptions as performed in this study can support the interpretation of a respondents' cognitive spatial representation, and the resulting non-use or refusal of using a green space.

A second limit of the method is that results are hardly generalizable or even transferable to other cities. As explained above, the results, e.g., the drawn sketches, depend on a person's individual recognition of his/her surroundings with spatial and non-spatial attributes framing the way people use open and green spaces while the behavior of people shapes and determines the image of the place, and vice versa. Consequently, the results, their interpretation, and the reasons behind them as described in this paper are strongly related to a triad of injustice in Halle, which includes historical legacies, recent socioeconomic context, and embedded UGS patterns, all visible in the neighborhood of Halle-Newtown. However, because this study is embedded into a broader systemic understanding of UGS filters, the detection of mental barriers seems to be a good proxy that led to some overall underlying context conditions. These conditions make for a straightforward reading of the quality of UGS and the interrelation between individuals and place (Kronenberg et al. 2021).

CONCLUSIONS

We deliver a concept- and context-based explanation for why some green spaces are underused and not recognized as options/opportunities. Facing such phenomena, most crucially, planners and decision makers need to develop a sensitive understanding to this complex setting and embedding of UGS into a local context in which an obviously green neighborhood with good availability of UGS coexists with strong and persistent mental barriers that prevent people from accessing them.

The municipal housing policy must be rethought in terms of its low income and migrant household allocation policy. Thus, adding accessibility to the availability of UGS benefit flows could be a way to lower additional perceived and infrastructure barriers that contribute to multiple injustices, i.e., income, affordable flats, stigma, between residents, and neighborhoods in the city. The UGS maps created in the very first part of this Halle-Newtown mental mapping study can greatly assist the discussion of UGS benefits flows in the neighborhood.

Mental mapping allowed us to virtually moderate between the different future expectations of the city administration and the inhabitants who feel suspended. What is more, mental maps shed light on a material expression of tacit knowledge (see Bharwani 2006). Of course, municipal planners and local activists cannot simply change the housing and real estate market of a city. It is, under current conditions, impossible for them to balance the income/pay gap between the different groups and households in Halle and Halle-Newtown being one core reason and filter for UGS non-use.

Responses to this article can be read online at:
https://www.ecologyandsociety.org/issues/responses.php/12675

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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.

Data Availability:

The data that support the findings of this study are only available on request from the corresponding author, DH. None of the data/code are publicly available because of restrictions as they contain personal drawings by the participants of this study, and they were promised at the beginning of each interview/mapping that their data will be stored by the researchers and only issued on personal request so that privacy of the participants can be secured as best as possible. The ethical approval for this research study was granted by Humboldt Universität zu Berlin.

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